THREE LECTURES ON THE *Organs* of *Reſpiration.*

Read at the
ROYAL COLLEGE of PHYSICIANS
at *London*, *A. D.* MDCCXXXVII.

BEING
The GULSTONIAN LECTURES for that Year.

To which is added
An APPENDIX, containing Remarks on ſome Experiments of Dr. HOUSTON's, publiſhed in the TRANSACTIONS of the ROYAL SOCIETY, for the Year 1736.

By *BENJ. HOADLY*, Doctor of Phyſick, Fellow of the COLLEGE of PHYSICIANS, and of the ROYAL SOCIETY.

Non fingendum, aut excogitandum, ſed inveniendum, quid Natura faciat, aut ferat. BACON.

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TO

Dr. *PELLET*,

PRESIDENT

OF THE

ROYAL COLLEGE of PHYSICIANS,

LONDON.

SIR,

AS the following Lectures were undertaken at Your Requeſt, it was no ſmall Satisfaction to me to find they ſo far anſwered Your Expectation in the Hearing, as to make you deſirous they ſhould appear in Print. And I own, it was with ſome Pleaſure I yielded to Your repeated Inſtances to that Purpoſe, becauſe I thought they gave me a ſort of Claim to Your Patronage.

BUT tho' Your Name would have been a ſufficient Apology for my ſending them to the Preſs exactly as they were read; I could not help thinking I owed ſo much to Your Character, as to let nothing appear in them, which I could expreſs in a clearer Manner, or ſet in a truer Light.

FOR this Reaſon, I ſat down to conſider them more carefully, than I had done before ; and ſoon found Occaſion not only for altering, but for enlarging, them in ſeveral Places.

SUCH as they are, I readily ſubmit them to the Publick : and am glad of the Opportunity they give me of paying you a grateful Acknowledgment for the many Civilities I have received from You : which I hope You will permit me to look upon as Marks of a Friendſhip, which I ſhall always eſteem as the greateſt Honour and Happineſs.

I am,

SIR,

Your moſt obliged

Humble Servant,

B. HOADLY.

LECTURE I.

OF THE

ACTION *of* RESPIRATION.

I HAVE fixed upon the Organs of Reſpiration, their Uſe in the Animal Oeconomy, and the Diſeaſes to which they are liable, for the Subject of theſe Lectures.

In the Firſt, I ſhall conſider the Make and Action of thoſe Parts only which are principally concerned in eaſy and undiſturbed Reſpiration, in order to point out more plainly by what peculiar Mechaniſm it is uſually performed in Health.

In the Next, I ſhall lay before you the different Opinions of Authors concerning the Uſe of Reſpiration in the Animal Oeconomy; and endeavour to explain what it is that makes a conſtant Supply of freſh Air ſo neceſſary to Life.

And in the Laſt, I ſhall ſhew from how many different Springs the Diſeaſes ariſe, to which the Organs of Reſpiration are liable; and, conformably to the Deſign of the Founder of theſe Lectures, I ſhall enlarge a little upon the Method of Cure to be followed in the moſt dangerous of theſe Diſeaſes.

IN purſuing this Deſign, I ſhall no where deſcend to a very particular Deſcription of the Conſtruction of the Parts, except where that Conſtruction, or the Deſign of it, is diſputed: becauſe the Make of the Parts in general is too well known to require a particular Deſcription *in this Place*; and the Philoſophical Reaſonings, which naturally offer themſelves, will draw out theſe Diſcourſes to a ſufficient Length.

LET us begin then with taking each of the Actions neceſſary to Reſpiration ſeparately into Conſideration.

IN Inſpiration, whilſt the Air is taking in at the Mouth and Noſtrils, the Cheſt is very perceptibly raiſed upwards, and the Abdomen preſſed forwards; by which the Cavity of the Breaſt is enlarged.

IN Expiration, the Cheſt ſubſides, the Abdomen is drawn in, the Cavity of the Breaſt is diminiſhed, and the Air is breathed out again.

FROM attending only to the outward Appearances of one, who breaths eaſily and freely, this is all that can be obſerved.

BUT when our Curioſity leads us to enquire into what paſſes within, we find the Lungs themſelves in Inſpiration, dilating ſo as to receive the Air, thus taken in; and in Expiration, contracting ſo as to throw it out again.

WHEN Reſpiration is diſturbed, the ſame Actions are performed, but with greater Difficulty. Thus you will ſometimes ſee the Neck ſtretched out, the Head erect, and the Muſcles of the Neck and Shoulders labouring together to raiſe the Cheſt, and enlarge its Cavity: and, at other times, when the Diaphragm and Abdominal Muſcles do by themſelves perform ſo much of the Action of Reſpiration, as is neceſſary to ſupport Life; you will ſee the Contents of the Abdomen alternately and remarkably ſqueezed into the Cavity

vity of the Breaſt, and forced out again, whilſt the upper Ribs and Shoulders remain quiet and unmoved.

FROM theſe Efforts of Nature in Diſtreſs, we ſee the Neceſſity there is, that the Cavity of the Breaſt ſhould be alternately enlarged and contracted, for the carrying on the Action of Reſpiration. But they are not ſufficient to convince us, that all the Parts of the Body, which at ſuch a Time are ready to lend their Aſſiſtance, are abſolutely neceſſary, or are always employed in the Action of Reſpiration, when it is performed freely, and with Eaſe.

IN the ſame Manner, ſince the Action of the Lungs can never be the Object of our Sight, without opening the Cheſt of an Animal alive; the Pain it muſt of Conſequence be in, muſt occaſion a violent and unnatural Dilating and Contracting of the Lungs. From this, indeed, we may be certain, that the Lungs dilate and contract, to receive and throw out the Air; but it will by no means follow, that they always do it with ſo much Force, or in ſo great a Degree.

SO that we may eaſily make too haſty Concluſions, and lead ourſelves into an Error, if we form our Notions of natural Reſpiration from Obſervations made upon a laborious or convulſive one.

OUR firſt Enquiry therefore ſhall be, in what Manner the Cheſt is formed; and what Muſcles are employed in raiſing and depreſſing it, in order ſufficiently to enlarge and contract its Cavity, for the carrying on an eaſy and free Reſpiration.

THE Fabrick of the Ribs, the Sternum, the Vertebræ of the Back, and the Diaphragm, to form the Cavity of the Breaſt; the Diviſion of this Cavity into two, by the Mediaſtinum; the filling up the Intervals between the Ribs by the Intercoſtal Muſcles; and the elegant and compleat Lining of the whole Cavity by the Pleura, for the more ſafe, warm, and convenient Situation of the Lungs and Heart; are ſo well known, that they need no particular Deſcription.

THE Ribs, together with their Cartilages, may in general be compared to ſo many Segments of different Curves, articulated at one End into the Vertebræ of the Back, and faſtened at the other to the Sternum.

NOW if the boney Subſtance of the Ribs reached quite to the Sternum, and was firmly connected to it; the whole Set of Ribs, together with the Sternum, could have but a very inconſiderable Motion, if any at all: and this muſt be one Motion in common to them all.

BUT as the Ends of the Ribs, where they are connected to the Sternum, are formed of a yielding and elaſtick Subſtance, each Rib may be conſidered ſeparately, as moving up and down upon both its Ends: One of which, at the Vertebræ, is abſolutely a fix'd Center of Motion; whilſt the other, at the Sternum, is but partly ſo, the whole Sternum readily conforming itſelf to the joint Motion of all the Ribs, either up or down.

CONSEQUENTLY, the Motion of the Breaſt, in the Action of Reſpiration, muſt be compounded of all the different Motions of the Ribs and Sternum: And therefore, if we deſigned an accurate and compleat Deſcription of this Motion of the Breaſt, we ought to take into our Conſideration all the minuteſt Differences in the Make of the Ribs themſelves, as well as in the Manner in which they are connected to the Vertebræ, to the Sternum, and to one another. But as our preſent Deſign is only to explain in general, by what Mechaniſm the Cavity of the Breaſt is alternately enlarged and diminiſhed; it will be ſufficient, to imagine a Number of Planes drawn thro' every Pair of oppoſite Ribs, and making a Number of Angles with the Back-bone. It will then be eaſy to ſee that the more acute theſe Angles are, the leſs will the Cavity be which is contained within the Cheſt; and the leſs acute they are, the greater will that Cavity be: and, conſequently, if the Ribs can be moved alternately, ſo as to make theſe Angles more and leſs acute, ſuch a Motion will alternately enlarge and contract the Cavity of the Breaſt.

IN determining what Muſcles are employed in performing theſe Motions, Anatomiſts are greatly divided: But if an Experiment may be depended upon, which I find mentioned by ſeveral Writers upon this Subject; we may ſafely conclude, that the Intercoſtal Muſcles (among which, I mean to reckon the Super- and Intra-Coſtales, deſcribed by *Verheyen)* are ſufficient to perform them, in the eaſy and natural Reſpiration we are now accounting for.

THESE Authors affirm, That when all the Muſcles, except the Intercoſtal Muſcles, which are any where about the Breaſt inſerted into the Ribs and Sternum of a Dog, were entirely divided, whilſt the Dog was alive, the Ribs continued in the ſame Motion as before.

NOW, tho' we ſhould depend upon the Truth of this Experiment, and throw every Muſcle, except theſe, out of our Conſideration, as of little or no Service, unleſs where a laborious and forcible Reſpiration is wanted; we ſhall ſtill find the Anatomiſts as much divided in their Opinions *how* theſe Muſcles act, as they were before *which* were the Muſcles concerned in Acting.

LET us therefore examine the Origin, Inſertion, and Direction of the Fibres of the Intercoſtal Muſcles; and ſee whether, from their Make, we cannot gain ſome Inſight into the Manner of their Acting.

BETWEEN every two Ribs on the ſame Side, there is a Space, which is filled up with Muſcular Fleſh, in which two different Ranges of Fibres are plainly to be diſtinguiſhed; one on the Outſide, and the other within: which are called the Intercoſtal Muſcles.

THE *external* Range of Fibres runs obliquely *down*, from behind forwards, having one Extremity faſtened to the *lower* external Edge of the ſuperior Rib, and the other to the *upper* external Edge of the inferior Rib.

THE *internal* Range of Fibres runs obliquely *up*, from behind forwards, having one Extremity faſtened to the *upper* internal Edge of the inferior Rib, and the other to the *lower* internal Edge of the ſuperior Rib.

THUS do theſe Ranges of Fibres run in oppoſite Directions, and interſect each other.

Borelli, and after him, others who have attempted a Mechanical Account of Reſpiration, look upon the whole fleſhy Subſtance, which fills up the Interval between every Pair of Ribs, as one Muſcle; and give to both Orders of Fibres, the ſame Office of raiſing the Ribs.

Willis, on the contrary, eſpouſing the more ancient Opinion, imagines, that each of theſe Ranges of Fibres has it particular Office; that whilſt one of them contracts, the other lengthens; and, conſequently, upon their acting alternately, that the Ribs are, by turns, elevated and depreſſed.

Borelli has endeavoured at a Demonſtration of the Impoſſibility of theſe Orders of Fibres ever performing the contrary Offices of dilating and contracting the Thorax.

Willis, indeed, offers no Demonſtration; thinking every one, who ſees how oppoſite their Fibres run, muſt immediately allot them Offices as oppoſite.

Borelli ſuffers himſelf, at ſetting out, to be drawn into a remarkable Error. He takes only two Ribs into Conſideration; and ſhews plainly enough (what no one will go about to deny) that neither of the Ranges of Fibres, which lie between, can, by their Action, puſh thoſe Ribs aſunder: The Conſequence of which would plainly be, that as the Office of one is to draw the lower Rib towards the upper, the other Range cannot poſſibly be an Antagoniſt to it.

BUT if he had taken three Ribs together, and obſerved the different Ranges of Fibres in the two Intercoſtal Muſcles, which lie on each Side the middlemoſt of theſe Ribs; he would have ſeen, at firſt Sight, that the internal Range in the lower Muſcle counter-acts directly the external Range in the upper Muſcle.

THUS (Fig. I.) let A B, C D, E F, be any three Ribs, lying next in order to one another, and moveable upon their Ends A, C, E. Let *a d*, *a d*, be the Direction of the external Range of Fibres in the upper, and *d e*, *d e*, the Direction of the internal Range of Fibres in the lower Intercoſtal Muſcle.

IS it not plain, even at firſt Sight, that if the Fibres, *a d*, *a d*, ſhorten, they will pull C D up towards A B; that if the Fibres, *d e*, *d e*, ſhorten, they will pull C D down towards E F; that the Fibres, *a d*, *a d*, cannot ſhorten, unleſs the Fibres, *d e*, *d e*, lengthen, and give way to them; nor *d e*, *d e*, ſhorten, unleſs *a d*, *a d*, lengthen: and conſequently, that when both theſe Ranges endeavour to act at the ſame Time, the middle Rib will remain in the ſame Place, without any more Motion, than if they had never endeavoured to act at all? Do not theſe Fibres therefore plainly appear to have all the characteriſtick Marks of antagoniſt Muſcles?

IF the ſame Figures were made for all the Ribs, and their Intercoſtal Muſcles, all the external Ranges of Fibres would be nearly parallel to *a d*, *a d*: and if they be ſuppoſed to act at once, would pull all the Ribs up, except the Uppermoſt.

IN the ſame Manner, all the internal Ranges of Fibres would be nearly parallel to *d e*, *d e*; and if they acted together, would depreſs all the Ribs except the inferior ones: which Office the *Serratus Poſticus Inferior* is very remarkably contrived to perform with great Force. To be convinced of which, there needs no more than to conſult *Euſtachius*'s Tables. Tab. xxxvi.

SINCE then theſe Ranges cannot both be contracted at the ſame Time; and, when they contract ſeparately, one Set elevates and the other depreſſes the Ribs: is it not highly reaſonable to conclude, that they were deſigned by Nature to act ſeparately, and ſucceſſively to each other?

WHEN, likewiſe, we conſider that it is in our Power to ſtop the Action of Reſpiration in whatever Part of it we pleaſe, for ſome time at leaſt; is it not reaſonable to believe we do it, as in other Caſes of the like Nature, by exerting a proportionable Degree of Force in both theſe Ranges of Fibres at the ſame time, ſo that neither may prevail?

THUS much in general upon the Action of theſe Muſcles. Whoever will go more minutely to work, will find himſelf more fully ſatisfied of the Truth of what is here ſaid: But my preſent Deſign will not allow me Time to be more particular.

WE ſhall next examine into the other external Appearance in Reſpiration; the alternate Motion of the Abdomen, in and out.

IN performing this Action, the Diaphragm, the Abdominal Muſcles, and the Air within and without the Body, are all of them concerned in their Turns.

THERE will be no Occaſion to give an accurate Deſcription of the Diaphragm; it being ſufficient for my Purpoſe to obſerve, that it is faſten'd at the edge, all the way on each ſide between the Back-bone and the Sternum, to the Baſtard Ribs, and to one, or perhaps two, of the True Ribs, croſſing each of them nearer their cartilaginous Endings as it approaches the Sternum; that it accurately ſeparates the two Cavities, ſo that no Fluid can paſs from one to the other, whilſt it is whole; that when it is relaxed, and the Ribs depreſſed, its Duplicatures form as it were two Purſes, convex towards the

Thorax, which conſequently take up room in that Cavity; and laſtly, that when the Diaphragm is ſtretched, and its Muſcular Fibres act, its Duplicatures are drawn out, and its Surface is reduced nearly to a Plane.

AT the ſame Time, therefore, that the external Ranges of Fibres in the Intercoſtal Muſcles raiſe the whole Set of Ribs, they muſt, together with them, raiſe the Edges of the Diaphragm; and with the Aſſiſtance of its Muſcular Fibres, reduce its Surface nearly to a Plane. The Conſequence of which, externally, is the apparent Swelling of the Cheſt and the Motion of the Abdomen outwards; and internally, a conſiderable enlarging of the Cavity of the Thorax.

TO theſe Actions immediately ſucceed the Actions of the *Serratus Poſticus Inferior*, and of the internal Ranges of Fibres in the Intercoſtal Muſcles, which draw the Ribs down into their former Situation, and with them the edges of the Diaphragm. At the ſame time the Muſcular Fibres of the Diaphragm ceaſe to act; ſo that the external Air, aſſiſted by the Action of the Abdominal Muſcles, on the Contents of the Abdomen, is at free Liberty to ſqueeze the Diaphragm up into the Cavity of the Thorax again: The Conſequence of which is internally diminiſhing the Cavity of the Thorax; and externally, the apparent ſubſiding of the Cheſt, and the Motion of the Abdomen inwards.

LET us now examine what is at the ſame time performed by the Lungs themſelves.

THE Inſide of the Lungs is by their Situation and Make, every where expoſed to the Preſſure of the external Air, which has a free Acceſs to it thro' the Wind-pipe: But the Outſide is ſo carefully encloſed in the Cavity of the Breaſt, that no viſible way is to be found for the external Air to inſinuate itſelf into it: and therefore it has perhaps too haſtily been concluded, that there is abſolutely no Air ever contained within the Cavity of the Breaſt.

THIS Opinion has the more readily been embraced, as it furniſhed an eaſy Solution of the Dilatation of the Lungs in Inſpiration. For when the Cavity of the Breaſt is enlarged, and there is nothing within it to preſs upon the outward Surface of the Lungs, it is eaſy to ſee that the external Air muſt, with all its weight, force itſelf into them, and by its Elaſticity dilate every the minuteſt Veſicle of which they are compoſed.

NOTWITHSTANDING the Eaſe with which Inſpiration is thus accounted for, this Hypotheſis (for it deſerves no better a Name) labours under many and unſurmountable Difficulties; which it were eaſy to mention, if the Point in diſpute did not admit of experimental Proof; as will appear from ſome Experiments taken from Dr. *Hales*'s *Hœmaſtaticks*, Page 83.

HE "ſlit Holes thro' the Intercoſtal Muſcles on each ſide "of the Thorax of a Kitten, and then placing it under an "Air-Pump-Receiver, he killed it in Vacuo. On opening its "Thorax, he found the Lungs *very red with coagulated* "*Blood*; which had flowed more freely into their Blood-Veſ-"ſels on the weight of the Atmoſphere's being taken off of "their Veſicles, both within their Cavities, and on their ſides "next the Thorax. Whereas if a Kitten be killed in Vacuo, "without having Orifices made into its Thorax, the Lungs "will in this caſe be *very white*; for whilſt the Air is drawn "away from the Veſicles thro' the Bronchia, the Air, which "is included in the Cavity of the Thorax, being dilated, *com-*"*preſſes the Lungs, and ſqueezes the Blood out of its Veſ-*"*ſels*, on which Account they are in this caſe found to be "*white.*"

"AND that the Air in the Thorax thus compreſſes the Lungs "in Vacuo, is evident hence. If the Body of a Kitten, as ſoon "as killed, be cut aſunder, juſt below the Diaphragm; and a "Weight be then tied to the Head, ſo as to make the obtrunca-"ted Part ſink under Water; and if in this Poſition, it be

" placed in Vacuo, the Diaphragm will dilate conſiderably, " and ſubſide again as ſoon as the Air is let into the Recei- " ver."

" A plain Proof (ſays the Doctor) that there is Air in the " Cavity of the Thorax; which, whilſt it thus, by its Expan- " ſion, dilates the Diaphragm, muſt needs at the ſame time " compreſs the Lungs; in which State they are found on open- " ing the Thorax: whereas Lungs taken out of the Thorax do " dilate in Vacuo, and continue ſo, even when Air is let into " the Receiver."

IF any one is curious to know how this Air does at firſt inſinuate itſelf into this Cavity, I can only refer him to the 112th and 113th Experiment in Dr. *Hales*'s *Vegetable Staticks*; where he may be informed with how very ſmall a Force Air will paſs thro' the Subſtance of the Lungs: And leave him afterwards to determine in his own Mind, whether it will not follow from thoſe Experiments, that the external Air muſt in like manner inſinuate itſelf into the Cavity of the Thorax, if ever that Cavity is void of Air.

EITHER this muſt follow, or an abſolute and conſtant Contiguity of the whole external Surface of the Lungs to the Parts which are next them: And how far this is from being always the Caſe, will appear from the Experiments we ſhall produce in the following Pages.

LET us therefore, upon the Strength of theſe Experiments, conclude that there is Air within the Cavity of the Thorax, and ſee what ſhare it will have in the Action of Reſpiration.

TO underſtand this clearly, let us ſuppoſe, after an Expiration is made, that the Lungs remain contracted, whilſt the Cavity of the Breaſt enlarges to its utmoſt Extent, in order to make the next Inſpiration. Then muſt the Air in the Cavity have more and more room to dilate into, and conſequently preſs leſs and leſs forcibly upon the outward Surface of the Lungs, than it did before. And if we now ſuppoſe the Lungs at Liberty, the external Air will immediately enter at the Wind-pipe, and equally and uniformly dilate every Part of the Lungs, till they fill ſo much of the Cavity as to reduce the Air without them to an Equilibrium with the Air within.

LET us, in the ſame manner, ſuppoſe (now an Inſpiration is made) that the Lungs remain dilated, whilſt the Cavity of the Breaſt contracts, in order to make the next Expiration. Then muſt the Air within the Cavity be condenſed into a ſmaller Compaſs, and conſequently preſs with a greater Force upon the external Surface of the Lungs; and if we now ſuppoſe the Lungs at Liberty again, they muſt every where be equally and uniformly compreſſed by this ſurrounding Air, till they ſubſide into a narrower Compaſs, and give room to that Air to reduce itſelf to an Equilibrium with the Air within them: which can not be done till the ſame Quantity of Air is thrown out of the Lungs that was before taken in.

UPON theſe Suppoſitions, therefore, the Lungs are dilated, and contracted, by the Difference of the Preſſures of the Air within and without them, occaſioned by the enlarging and contracting of the Cavity of the Thorax.

NOW what has here been ſuppoſed to be done by Starts, and with a conſiderable Force, is in Nature performed gradually, and with the greateſt Eaſe.

FOR as ſoon as the Cavity of the Breaſt begins to be enlarged, the Equilibrium is deſtroyed between the Air within, and without the Lungs; and the inſtant the Difference of the Preſſures is ſufficient to dilate them, the Air begins to enter at the Wind-Pipe; and ever after that, during the gradual enlarging of the Cavity, it equally and uniformly diſtends the Lungs, continually ſupplying the Space deſerted by the Ribs and Diaphragm, and conſtantly preſerving the ſame Difference of Preſſure between it, and the Air within the Cavity, till that

Cavity is enlarged to its greateſt extent: And when it begins to diminiſh, the Superiority of Force begins to be on the ſide of the Air within the Cavity; and as ſoon as it becomes ſufficient to ſqueeze together, and contract the Lungs, the Air within them begins to yield, and go out, as before it entered, at the Wind-Pipe: And thus during the whole time the Cheſt is contracting, will the Air without the Lungs, with the ſame gentle Degree of Force, equally and uniformly preſs upon every Part of the external Surface of the Lungs, till it has gradually forced out the ſame Quantity of Air which had before been inſpired.

THUS the alternate and contrary Actions of Reſpiration are perform'd with equal Eaſe, by the Aſſiſtance of the Air within the Cavity: which ſeems to be deſigned, as well to prevent the Lungs from being at any time too ſuddenly or too forcibly dilated in Inſpiration, as to preſs uniformly upon their whole external Surface, and equally contract every Part of them in Expiration.

THIS Way of accounting for the Action of Reſpiration, ſeems to be very ſtrongly confirmed by an Experiment of Dr. *Hales*, mentioned in his *Hæmaſtaticks*; and by two others, which were lately made, in order to diſcover what Effect letting the external Air into the Cavity of the Thorax would have upon the Action of Reſpiration.

Dr. *Hales* gives this Account of his Experiment, p. 77. "I made an Inciſion of two Inches length between the Ribs "in the Thorax of a Dog on the right ſide. At firſt opening, "*the Lungs were dilated ſo as to fill up the Cavity of the* "*Thorax*; for they preſſed againſt the inward Orifice of the "Wound, and *continued in this State for ſome time*. But "then as *this right Lobe of the Lungs fell* gradually more "and more, ſo the Dog *ſhewed* more and more *Uneaſineſs in* "*breathing*; and on *dilating* and *contracting* the Thorax by

" the Action of the Diaphragm, the Air ruſhed briskly *in* and
" *out* at the Inciſion. But when the Orifice was covered by
" drawing the Skin over it, the Dog breathed in a natural
" way."

THE Doctor obſerved, " that on ſtraining, the collapſed
" right Lobe of the Lungs would inſtantly dilate ſo vigorouſly,
" as to puſh the lower part of the Lobe one, two, and ſome-
" times three Inches length out thro' the Inciſion."

THE Doctor in his Obſervations upon this Experiment ſays,
" Hence there does not ſeem to be ſo much danger as has been
" imagined in the *Paracenteſis*, or Inciſion into the Thorax,
" *&c.* for tho' whilſt the Orifice was open, this Dog breathed
" with difficulty; yet the left Cavity of the Breaſt being by
" means of the Mediaſtinum ſtill cloſed, the left Lobe of the
" Lungs played to and fro to ſuch a degree, that the Dog
" breathed enough to keep up the Circulation of the Blood
" for near a quarter of an Hour, as I purpoſely tried; and
" the Uneaſineſs in breathing not encreaſing in ſo long a time,
" it is reaſonable to believe that he would have lived in that
" manner for ſome Hours. But if the left Cavity of the Tho-
" rax had alſo been open at the ſame time, he would doubt-
" leſs have died ſoon."

AS there ſeemed nothing wanting to make this Experiment compleat, but actually admitting the Air into both Cavities of the Breaſt at the ſame time; and as I had often heard it had been tried, but without ever meeting with a ſatisfactory Account of the Succeſs, I was reſolved on this Occaſion to ſee it performed myſelf.

ACCORDINGLY the Experiment was tried two different Ways, with ſuch different Succeſs, that it will be proper to give a full Account of them both.

IN the firſt, we laid bare the Sternum, and part of the Ribs of a pretty large Dog, and applying a large Trepan, made a wide Orifice into the Thorax. Immediately upon taking out the Piece, the Air was thrown forcibly out at the Hole, by a violent Dilatation of the Lungs; which continued for ſome time, and was ſo great, that Part of the Lungs was thruſt out at the Hole. When the Lungs ſubſided, a Finger was introduced, and a Perforation made thro' the Mediaſtinum; by which means we were certain that the Air had free Ingreſs into both Cavities. Upon this, another violent Dilatation of the Lungs followed with ſuch Force, as threw the Ends of both Lobes of the Lungs out at the Hole, where they continued for a while. Then the Lungs contracted, but not quite with ſuch apparent Violence as they ſeemed at firſt to dilate with: and thus they dilated, and contracted again, and again, irregularly, and unnaturally, with leſs and leſs Force, for eight, nine, or ten times; then they ſubſided, and collapſed; and the Dog expired.

THE whole Time, from the Making the Orifice to the Death of the Dog, was not five Minutes; and no ſooner did the violent Motions of the Lungs ceaſe, but the Dog immediately expired.

IN the ſecond Experiment, we introduced a long and large Trochart, together with its Canula, between the Ribs of a Dog, as near the Sternum as we could, and thruſt it in ſo far, that it pierced the Mediaſtinum, and reached to the oppoſite Ribs. In doing this we entirely avoided hurting the Lungs themſelves. Whence, by the by, it is probable that the Lungs are not continually applied cloſely to the inner Surface of the Thorax; for if they had been ſo, they muſt in all probability have been wounded by the Trochart, which paſs'd quite acroſs the Cavity of the Thorax.

WHEN we had proceeded ſo far, we could not but be ſurprized at the great Force that was required to keep the Trochart in: which it will be difficult to account for any otherwiſe, than from the Force of the Air within the Cavity, which was greatly compreſſed by the violent dilating of the Lungs, which immediately followed upon thruſting the Trochart in. For as the Dog was thrown upon his Back, the Trochart lay above, and acroſs the dilating Lungs; and the Force of them alone would rather have kept it faſter in the Wound, than have thruſt it out: But the Force of the Air, when compreſſed within the Cavity, muſt be exerted againſt the End of the Trochart only, and ſo puſh it directly outwards. And that this was the Caſe, appeared upon taking out the Trochart; for then the Canula remained very quietly in the Wound, when a Paſſage was opened for the compreſſed Air to eſcape. This Force, therefore, which is required to keep the Trochart in, is a Confirmation of the Opinion, that there is Air contained within the Cavity of the Breaſt.

The Canula was made with Holes in the Sides; ſo that the Air was undoubtedly let into both Cavities of the Thorax: However, to remove all Objections that could be made, another Trochart was in like manner thruſt into the other ſide, and paſſing thro' the Mediaſtinum, its Canula was left in, croſſing the firſt.

As to the Motion of the Lungs themſelves, there was nearly the ſame Appearance in both Lobes, that Dr. *Hales* deſcribed in the right Lobe only.

Immediately upon making the Wound with the firſt Trochart, followed a very great and forcible Dilatation of the Breaſt, which was repeated now and then at very irregular Intervals of Time; to each of theſe ſucceeded as remarkable and forceable a Contraction: But it was not long before the Breaſt gradually ſubſided ſo much, that we began to imagine the Lungs were collapſing; and ſhould have expected the ſudden Death of the Dog, if the Motion of one of the Canulæ, which reſted upon the Heart, had not ſhewn us that the Heart ſtill beat regularly and ſtrongly.

UPON this, we took out one of the Canulæ, and having ſomewhat enlarged the Wound, we introduced our Fingers; when we could plainly feel the whole Subſtance of the Lungs alternately dilate, and contract, at proper and regular Diſtances of Time, correſponding to the Motions of the Ribs and Diaphragm: And notwithſtanding theſe Dilatations and Contractions were very ſmall, the Heart beat freely, and the Pulſations in the Pulmonary Artery were plainly to be felt.

IN this manner, with one of the Canulæ in his Breaſt, did the Dog continue to breath for above two Hours; and was at laſt as likely to live as at any time in the two Hours before. So that Death is by no means the immediate Conſequence of the meer Admiſſion of Air into both Cavities of the Breaſt at a time.

THERE is ſomething very remarkable in the different Succeſſes of theſe two Experiments; which may ſerve, at leaſt, to account for the different Opinions of Authors upon this Subject: who, on both ſides, ſeem to ſpeak from Experience, and refer their Readers to the Effects of live Diſſections.

IT will be worth our while to examine carefully into the Circumſtances of each Experiment, and ſee whether this Difference cannot be accounted for.

THE firſt Appearances, upon making the Orifices, were nearly the ſame in both theſe Experiments.

IN the firſt, the Lungs were ſo violently dilated, that the Ends of the Lobes did more than once ruſh out at the Wound, and continued in that ſtate for ſome time.

IN the ſecond, as the Canulæ, which were in the Breaſt, prevented the Lungs from being thruſt out thro' the Orifices, we could only judge from the Appearances, that there was the ſame violent Dilatation; but the Trochart was no ſooner in, than the Breaſt was very much dilated, and continued ſo for a conſiderable time.

AND in Dr. *Hales*'s Experiment likewiſe, the Lungs were conſiderably dilated, ſo as to preſs againſt the inner Orifice of the Wound, and remained ſo for ſome time; and upon any ſtraining of the Dog, the lower Part of the Lobe was violently thrown out one, two, or three Inches length at the Wound.

IN order to account for this violent Dilatation of the Lungs, as well as for the Ends of the Lobes being thrown out at the Wounds; the Pain which the Animals muſt neceſſarily have been in, whilſt the Wounds were making, muſt be taken into Conſideration. For this Pain muſt naturally produce an Endeavour in the Animal to expreſs it by Crying; and Crying can no otherwiſe be produced, than by performing an Expiration, and at the ſame time contracting the Orifice of the Wind-pipe, in order to force the Air thro' a ſmall Orifice with a proper Velocity, to form the acute Sound of Whining. The Air therefore in the Cavity muſt preſs upon the external Surface of the Lungs with conſiderable Force, at the ſame time that the Air within them is prevented from going freely out at the Wind-pipe; and conſequently, they will be kept tight againſt the Ribs, by the Preſſure of the Air within the Cavity, and at the ſame time be rendered ſtiff by the compreſſed Air within them. This will be doing whilſt the Wound is making; and conſequently, when the Wound is made, the Lungs will be ſeen in a dilated State, preſſing againſt the Orifice of the Wound; and if the Animal ſtrains with great Violence, the Air will be forced thro' the contracted Orifice of the Wind-pipe with greater Velocity; the Lungs themſelves will not be ſo much dilated; the Air within the Cavity will preſs them more violently againſt the Ribs; and conſequently, the moſt flexible Parts of them (which are the taper Ends of the Lobes) will be forced out at the Wounds, more or leſs, in proportion to the Strength and Quickneſs with which the Animal is ſtraining; and the Ends of the Lobes will continue out, till the prolonged Expiration is over, and no longer; unleſs they ſhould accidentally ſtick faſt in the Wound, which has ſometimes been the Caſe. For when the Expiration ceaſes, the Crying muſt ceaſe with it; an Inſpiration muſt follow; the Air in the Cavity muſt have room given it to dilate into; and conſequently, the Ends of the Lobes, (protruded only by the Force of that Air, when condenſed) muſt return in again, and remain ſo till the Dog begins again to cry.

This I conceive to be the true Way of accounting for the firſt Appearances in all theſe Experiments.

But why did one of theſe Dogs continue alive for above two Hours; and the other, ſcarce a Moment after the violent Dilatations and Contractions ceaſed?

I am apt to believe it was owing entirely to the different Sizes of the Apertures made into the Cavity of the Thorax. The Orifice, made by the Trepan, was about the Bigneſs of a Crown Piece: The two Orifices made by the Trocharts were not ſo big, taken together, as a Shilling.

Now from what has been ſaid before, Reſpiration is carried on, by the Motions of the Ribs and Diaphragm alternately giving the Superiority of Force to the Air within and without the Lungs; conſequently, ſo long as the Air within the Cavity can be alternately compreſſed and dilated, ſo as now to be more denſe, and now more rare, than the Air within the Lungs, ſo long will Reſpiration go on.

Agreeably to this, in Dr. *Hales*'s Experiment, whilſt the Orifice was open, the Dog breathed with Difficulty; becauſe in Inſpiration, when the Air in the Cavity ſhould have been rarefied, the external Air ruſhed in thro' the Wound and prevented it; and in Expiration, when it ſhould have been condenſed within the Breaſt, it ruſhed out at the Wound. But when the Skin was drawn over the Orifice, Reſpiration went on as regularly as before the Wound was made; becauſe the Air within the Cavity had then a Power of dilating when the Thorax was enlarged, and muſt be condenſed when the Thorax was contracted, exactly as in natural Reſpiration.

SO if you ſuppoſe a ſmall Orifice to be made on each ſide of the Breaſt; it will follow, that when the Cavity enlarges, the external Air will enter faſter thro' the Wind-pipe into the Lungs, than thro' theſe ſmall Orifices into the Cavity, and the Lungs will have time to dilate before the external Air can enter into the Cavity to prevent them; and, for the ſame Reaſon, upon contracting the Cavity of the Breaſt, and condenſing the Air both within the Lungs and the Cavity, the Air has a freer Paſſage to eſcape out of the Lungs at the Wind-pipe, than out of the Cavity at the Orifices; and conſequently, in this Caſe, the Action of Reſpiration will be performed, tho' not ſo perfectly as in a natural State; and the ſmaller theſe Apertures are in proportion to that of the Wind-pipe, the more like the natural will the diſturbed Reſpiration be.

SO that probably, by this way of Reaſoning, the Death of the Dog in the firſt Experiment was owing to the Size of the Aperture; which was ſo large, that the dilating and contracting of the Thorax could produce no Alteration in the Denſity of the Air in the Cavity, the Communication being too great and too ſudden with the open Air.

WHEREAS, in the other Experiment, the Apertures were ſo ſmall, that the free Paſſage of the Air thro' them was retarded; and conſequently, ſome Alteration, tho' but an inconſiderable one, was made in the Denſity of the Air within the Cavity, by the Motion of the Ribs and Diaphragm; and ſome ſort of Reſpiration was accordingly kept up.

I ONLY offer this as an Attempt to account for this remarkable Difference in the Events of theſe Experiments, not having had an Opportunity, or indeed any Inclination, to try more of theſe cruel Experiments, in order to be fully ſatisfied that this was really the Caſe.

UPON the Whole, therefore, may we not conclude,

1. THAT the Actions of the external Ranges of Fibres in the Intercoſtal Muſcles raiſe the Ribs and Sternum, both upwards and forwards?

2. THAT the Diaphragm, at the ſame time, by the Action of its Muſcular Fibres, puſhes the Contents of the Abdomen downwards and forwards?

3. THAT the Cavity of the Thorax is by both theſe Motions conſiderably enlarged?

4. THAT the enlarging the Cavity of the Thorax is not barely deſigned for the containing the inflated Lungs, which in common Reſpiration do not dilate to the utmoſt they are capable of? But,

5. THAT the great Uſe of this enlarging the Cavity of the Thorax is to give room to the encloſed Air to dilate, by which its Elaſticity, and conſequently, its Preſſure upon the external Surface of the Lungs, is diminiſhed?

6. THAT whilſt the Cavity of the Thorax is thus enlarging, the Lungs are gradually and gently dilated with a Force equal to the Difference of the Preſſures of the Air within, and without them?

7. THAT immediately upon the Ceſſation of the Actions of the Diaphragm, and the external Ranges; the internal Ranges of Fibres, aſſiſted by the *Serratus Poſticus* inferior, begin to act and depreſs the Ribs and Sternum?

8. THAT the Abdominal Muſcles and the external Air do, at the ſame time, by the Intervention of the Contents of the Abdomen, ſqueeze up the Diaphragm into the Thorax again?

9. THAT the Conſequence of this, is diminiſhing the Cavity of the Thorax, and compreſſing the Air within it; and conſequently, encreaſing its Preſſure upon the external Surface of the Lungs?

10. AND laſtly, that the Air within the Lungs having nothing to keep it in, muſt yield and give way; and conſequently, the Lungs will, during the Depreſſing of the Ribs, be gradually, gently, and uniformly compreſſed; and the Air thrown out again with a Force equal to the Difference of the Preſſures of the Air within and without them?

THUS have I endeavoured to explain the Action of Reſpiration, and the Mechaniſm by which it is performed; and I have choſen to be ſo particular in enumerating the Steps taken in the Performance of it, that I may with the greater Diſtinctneſs proceed to examine the different Opinions of Authors concerning the Uſe of Reſpiration in the Animal Oeconomy, which is the Subject of my next Diſcourſe.

LECTURE II.

OF THE

USE *of* RESPIRATION *in the* ANIMAL OECONOMY.

SOON after the Circulation of the Blood was diſcovered, and the Certainty of it eſtabliſhed beyond diſpute, it was readily allowed by almoſt every one, that the Health, Strength, and Nouriſhment of the Body was owing to the Blood's being duly and conſtantly circulated thro' every Part of it; and that in whatever Way thoſe Parts were nouriſhed, the Nouriſhment itſelf was conveyed by the Blood: and conſequently, that the Blood muſt, in a healthy State of the Body, be ſo conſtituted as to contain the Particles deſigned by Nature for Nutrition; and at the ſame time to preſerve itſelf in ſuch a Degree of Fluidity, as would enable it to paſs thro' every the minuteſt Veſſel.

THIS led the Way to an Enquiry, How this particular Conſtitution of the Blood was ſo duly kept up whilſt it was in the Body, which every one knew it would immediately loſe upon being taken out of it?

The Lungs were ſoon fixed upon as the moſt likely of all the Parts of the Body for performing this neceſſary Office; and not without very good Reaſon. For, beſides that it followed from the Make of the Heart, and the Diſtribution of the Pulmonary Veins and Artery, that no Portion of Blood, how minute ſoever, could perform two Circulations, without paſſing thro' the Lungs; there was an obvious Difference in the Colour of the Blood after it had paſs'd thro' the Lungs, from the Colour of it before: Whence it was reaſonable to conclude, that ſomething very material happened to it in that Viſcus.

The Difference of Colours in the Blood in the Veins and Arteries had been obſerved long before the Circulation was thought of; and it was accordingly divided into Venal, and Arterial Blood: and theſe were looked upon then as different Fluids, performing different Offices in the Animal Oeconomy.

But when the Courſe of the Circulation was well underſtood, and it was known for certain that the Fluid, both in the Veins, and Arteries, was one and the ſame Blood continually viſiting all Parts of the Body; that every Portion of it, after it had paſſed the minuteſt Veſſels, returned to the Heart in the *Veins* of a very different Colour from what it had in the *Arteries*; that it retained this new Colour even till after it had paſſed the Heart, and the Pulmonary Artery had conveyed it to the Lungs; and laſtly, that it no ſooner came out of the Lungs, than it appeared in the Pulmonary Vein reſtored again to the Colour it was of in the Arteries: it was thought reaſonable to conclude in general, that the Conſtitution, as well as the Colour, of the Blood was different before from what it was after it had paſſed the Lungs; that the Arterial Blood did more particularly contain the proper Nouriſhment which was to be convey'd by the Circulation to every Part of the Body; and that whatever was wanting in the Venal Blood for the Purpoſes of Life, whether from a loſs of Nutritious Particles, or ſome Variation in the Degree of its Fluidity, was given to it in its paſſage thro' the Lungs, where it ſo plainly recover'd its Arterial Complexion.

AND as every one was then buſy in making Enquiries into all Parts of the Animal Oeconomy; it was not long before this Opinion received a very ſtrong Confirmation: for the very Veſſels were found, by which thoſe Parts of our Food, which are deſigned for the Nouriſhment of the Body, are taken up and conveyed into the Blood, under the Form of a milky Fluid, ſince known by the Name of *Chyle*.

FROM this Diſcovery it appeared, that the *Chyle*, after it is duly prepared and digeſted, is almoſt continually preſſed thro' the Thoracick Duct, and lifting up the Valves in the Subclavian Vein, is forced in ſmall Quantities into it; whence, following the Courſe of the Veins, it is carried together with the Blood which returns from the ſuperior Parts of the Body into the *Sinus Venoſus*: and here meeting with the reſt of the Blood which returns from the inferior Parts of the Body, it is together with them both conveyed into the Heart, and thence into the Pulmonary Artery.

HENCE it was evident, that there was continually paſſing into the Lungs a Portion of Venal Blood, with a ſmall Share of *Chyle*, not yet duly and intimately mixed with it; and as there was continually paſſing out of them a Portion of Arterial Blood, differing very viſibly both from the *Chyle* and Venal Blood; it was very reaſonably imagined, that this Difference aroſe from the Venal Blood's being more duly blended together, more intimately mixed with this Supply of *Chyle*, and ſo altered in its Conſtitution, whilſt it was paſſing thro' the Lungs, as to be more fitted for the Offices of the Circulation: And hence it was concluded, that the Lungs were not only ſo ſituated as to receive each Portion of Blood at its return to the Heart, after every Circulation, and together with it what *Chyle* was ready prepared and digeſted; but ſo conſtructed likewiſe, as intimately and duly to mix them together into one uniform Fluid, of ſuch a Degree of Fluidity as enabled it to paſs the minuteſt Veſſels in the Body.

And as a conſtant Supply of freſh Air was, by the alternate Actions of Inſpiration and Expiration, admitted into the innermoſt Receſſes of the Lungs, whilſt theſe Alterations were making in the Blood within them; which Supply of freſh Air was known to be abſolutely neceſſary to Life: it was imagined that ſome vivifying Aura was imbibed by the Blood in its Paſſage thro' the Lungs, without which it would be abſolutely unfit for the more ſecret Purpoſes of Life.

These Conſiderations naturally led the Way to ſtill farther Enquiries into the particular Mechaniſm of the Lungs themſelves, and the Manner in which ſo advantageous and neceſſary an Alteration was made in the Blood whilſt it is paſſing thro' them.

In order to underſtand what has been ſaid upon a Subject of ſo nice a Nature, it will be neceſſary to give a Deſcription of the Make of the Lungs; but not ſo minute a one as might at firſt be imagined: It will be ſufficient for our Purpoſe to conſider them as conſiſting only of Air-Veſſels, Arteries, and Veins; by the firſt of which the external Air is alternately admitted into, and thrown out of their very inmoſt Receſſes; and by the latter, the whole Maſs of Blood is continually circulating thro' their minuteſt Veſſels.

The external Air is received by the Trachea Arteria; which, as ſoon as it enters the Lungs, dividing into the Bronchia, conveys it to the different Lobes which lie on each ſide the Mediaſtinum. Theſe Bronchia are divided and ſubdivided inſenſibly into ſmaller, and ſtill ſmaller Branches on each ſide, and conſtitute the Lobes. Each of theſe Lobes may be ſubdivided into Lobules; and in theſe ſmalleſt Lobules the Air-Veſſels terminate in Veſicles, which communicate one with another.

So that thro' the Bronchia the Air is admitted into the Veſicular Cavities of every the minuteſt Lobule.

TO give a proper Notion of the Blood Veſſels, it will be ſufficient to obſerve, that the Pulmonary Artery enters the Lungs nearly where the Trachea Arteria begins to divide; and dividing immediately into two, follows the Air-Veſſels in all their Progreſs thro' the Lungs, dividing and ſubdividing nearly as they do, till at laſt it ends in a ſurpriſingly-minute Network of Capillary Branches, inoſculating with one another, and diſtributed all over the Sides of the Veſicles deſcribed above.

THE Blood brought by this Artery, and diſtributed thus thro' every Part of the Lungs, is taken up again by the minuteſt Branches of the Pulmonary Veins: which continually uniting with one another, as they carry it back to the Heart, grow gradually larger and larger; are conſtantly ſituated cloſe by the Arteries and Bronchia; and end at laſt in the four ſhort Veins which go out of the Lungs nearly where the Artery enters. *Vide* Euſtach. *Tab.* 27. *Fig.* 13.

FROM this Conſtruction of the Blood-Veſſels, it moſt undoubtedly follows, that the Venal Blood, together with the *Chyle*, which is brought in one large Veſſel into the Lungs, muſt paſs thro' the very minute Veſſels, which are diſtributed over the Sides of the Veſicles, before it can be taken up by the Veins and returned to the Heart; the Conſequence of which is, being firſt divided into the minuteſt Streams, and afterwards gradually mixed together again.

AND from the Diſtribution of the Air-Veſſels of the Lungs, it follows, that the Air muſt be continually admitted into the Cavity of theſe Veſicles; by which Means it is brought within leſs than the thouſandth Part of an Inch of being in immediate Contact with the Blood, whilſt it is divided into the minuteſt Streams; there being nothing between but the exceſſively fine Sides of perhaps the minuteſt Veſſels in the whole Body.

AND from the alternate Actions of Inſpiration and Expiration, it will follow, that the Surfaces of theſe Veſicles, together with the Blood-Veſſels, which are diſtributed upon them, muſt be alternately preſſed upon by the Air within and without them, and conſequently be in continual Motion.

LET us therefore carefully and ſeparately examine into the Effects which are likely to follow, 1. from the Venal Blood and *Chyle*'s being thus divided into exceedingly minute Streams, and afterward reunited again into one; 2. from the different Preſſures which it is alternately expoſed to in the minute Blood-Veſſels; and laſtly, from the Motion of theſe Blood-Veſſels, which is the Conſequence of this different Preſſure; and ſee whether they are ſufficient to account for the remarkable Difference which is found in the Blood when it is taken up by the Veins and united again into larger Streams.

FIRST, the ſeparating the Blood into the minuteſt Streams, and uniting it again into a large one, is no more than what is performed exactly in the ſame manner to the whole Maſs of Blood in every Circulation, by the whole Set of Arteries and Veins in the Body; and to Part of it at a time in almoſt every particular Viſcus: in one Caſe for the ſecret Work of Nutrition, and in the other for the better carrying on the Secretion that is to be made in every particular Viſcus.

BUT in both theſe Caſes, it is the Arterial Blood which is thus divided into the minuteſt Streams; and after every ſuch Diviſion, reuniting its Streams, it conſtantly returns of that Conſtitution which denominates it Venal Blood.

SINCE then we find that Arterial Blood is changed into Venal, as well as Venal into Arterial, after having been ſeparated into minute Streams, and united again; this Conſideration alone will be of little or no Service in our Enquiries.

LET us, therefore, next examine what the Blood undergoes in paſſing thro' the Lungs from the Preſſure of the Air upon the Sides of the Veſſels thro' which it circulates.

FROM what was ſaid in my firſt Diſcourſe, it will be eaſy to underſtand, that at every Expiration the Air is thrown out of the Lungs by the Motion of the Sides of the Veſicles; and that in order to do this, they muſt ſuſtain and overcome the Weight of ſo much Air as they remove. So that before we can determine what the Blood undergoes in circulating among theſe Veſicles, whilſt they are thus throwing out the Air, we muſt firſt ſee what this Preſſure is which the Sides of the Veſicles muſt ſuſtain.

IF for this Purpoſe we conſult the Writers of the beſt Character for their Knowledge, not only in the Anatomy of the Parts, but even in Philoſophy and Mathematics; we ſhall find them ſo widely differing in their Accounts, that one unacquainted with their Works would rather think they were gueſſing at the Truth, than that each of their Opinions was backed with Mathematical Calculations.

ONE aſſures us, that the Preſſure of Air overcome in gentle and ordinary Reſpiration, is equivalent to the Weight of fourteen Thouſand Pounds; another contents himſelf with a bare Hundred; and a third makes it ſo inconſiderable, he can hardly find a known Preſſure inſignificant enough to compare it to; whilſt all the Three appeal to Mathematical Demonſtration for the Truth of what they aſſert.

BUT whoever will examine the different Methods in which theſe Gentlemen form their Calculations, will readily give the Preference to the Laſt: He will never find him attempting to build, till he has got a ſure and ſolid Foundation prepared for him by Nature; and accordingly, the Reſult of his Calculation is agreeable to the Eaſe with which Nature carries on all her moſt conſtant Works.

THE *Impetus* (ſays this Author) which the internal Surface of the Lungs ſuſtains in a common Reſpiration, is leſs than the Motion of the gentleſt Dew deſcending from the Sky, being equal to the Motion of a Column of Water (whoſe Baſe is the internal Surface of the Lungs, and whoſe Height is but the $\frac{1}{70000}$ Part of an Inch) moving with a Velocity no greater than what would carry it thro' an Inch in a Second of Time.

THAT this is the Truth, no one will doubt, if he reflects upon the Eaſe with which Reſpiration is commonly performed; or if he conſiders attentively the Mechaniſm of the Parts, as we explained it above.

CONSIDER the Make of the Veſicles, how thin and pliable they are; how they are ſituated in the Lungs; what free Acceſs the external Air has to them; and that they are all encloſed by the external Coat of the Lungs: Conſider that this external Coat is ſurrounded every where by the Portion of Air contained within the moveable Walls of the Thorax; follow in your Minds the Motions of the Breaſt in Inſpiration and Expiration; and you will readily ſee that the internal Surface of theſe Veſicles cannot ſuffer more from the Preſſure of the Air, than the Surface of your Hands, when you move them to and fro with the ſame gentle Velocity.

IN Inſpiration, the Ribs are gradually moved upwards, and the Diaphragm gradually puſhed out; the Air within the Cavity would therefore gradually have more and more Room allowed it to dilate into, if the Air within the Lungs did not as gradually dilate the Veſicles and ſwell the Lungs, ſo as always to keep the Air in the Cavity very nearly of the ſame Degree of Denſity: So that little or no Alteration is made in the Preſſure of the Air, either within or without the Lungs; only more Air is ſuffered to enter the Lungs: but Air does not preſs in proportion to its Quantity, provided the Space enlarges with the Quantity, as here it is permitted to do.

FOR the ſame Reaſon, in Expiration, as the Cavity of the Thorax is gradually diminiſhed, the Air is gradually puſhed out of the Lungs; but the Preſſure is no where much greater than it was before.

INDEED if the Air was prevented from going out of the Lungs, there would gradually, as the Breaſt ſubſided, be more and more Preſſure upon both the internal and external Surface of the Lungs, becauſe the Air both within and without the Lungs muſt of Conſequence be compreſſed; and as the Orifice of the Wind-pipe is but ſmall, if the Cavity of the Breaſt was greatly to be diminiſhed at once, there would ariſe a conſiderable Difference of Preſſure upon the Lungs; becauſe the Air would be compreſſed faſter than it would have Power to dilate: But as the Cavity of the Breaſt does, in eaſy Reſpiration, gradually enlarge and contract, and conſequently allow Time for the Air to paſs freely in and out thro' the Wind-pipe; the Preſſure of the Air upon the Veſicles, or the Action of the Veſicles upon the Air, is no more than what every Part of the Body undergoes, that is in the ſame Degree of Motion.

FOR any Advantage therefore which can ariſe to the Blood from the Preſſure of the Air alone upon the Veſſels in which it circulates, it equally enjoys it in every other Part of the Body, as well as in the Lungs.

WE are next to enquire, What Degree of Motion is given to the Sides of the Veſicles by the alternate Motions of Reſpiration, and what Effect it will have on the Blood?

INDEED if we argue from the violent Motions of the Lungs, which happen upon opening the Breaſts of living Animals, where they are now ſtretched out with ſuch Force, as almoſt to crack the Veſſels which compoſe them; and now ſo contracted and ſqueezed together, that one would never expect to ſee them dilated again; we might, perhaps, be led to believe the Motion of the Veſicles worth our Conſideration: But even in this Caſe, the Blood would not be more acted upon by the Sides of its Veſſels, than it muſt be in the minute Veſſels of the Muſcular Parts of the Body in hard Labour or violent Exerciſe; and yet the Blood returning in the Veins after ſuch

Muſcular Action, has no more of the Arterial Conſtitution, than at any other time. It could not therefore be concluded, that the Arterial Conſtitution accrues to the Blood from the irregular Motions of the Sides of the Veſicles, even tho' there was always ſuch a conſiderable Motion given to them in Reſpiration.

BUT if we conſider how eaſily Reſpiration is performed in Sleep, when the Body is moſt recruited, and the moſt ſecret Offices are carrying on; how gently, and yet how freely, the Air is reſpired; and beſides this, how much Air is conſtantly retained within the Lungs: we ſhall find Reaſon to conclude, that the Veſicles of the Lungs are at all times conſiderably expanded, tho' they are more ſo in Inſpiration, and leſs in Expiration.

IF likewiſe we reflect upon what was delivered above, both from Calculation and the obvious Mechaniſm of the Parts, concerning the Smallneſs of the *Impetus* of the internal Surface of the Lungs, and compare it with the Time an eaſy Expiration is performing; we ſhall be very well ſatisfied how inconſiderable the Velocity of the Sides of the Veſicles is in ordinary Reſpiration.

SO that it ſeems probable, that the Blood-Veſſels, which are diſtributed about the Coats of theſe Veſicles, receive pretty nearly the ſame Degree of Motion from free and eaſy Reſpiration, that the Blood-Veſſels about the Coats of the Viſcera do from their Periſtaltick Motion; and if this Degree of Motion is of any conſiderable Uſe in arterializing Venal Blood, why does it not appear in the Blood which returns from the Viſcera by its having ſome Degree at leaſt of this Arterial Conſtitution?

UPON the Whole, therefore, does it appear that any thing more happens to the Blood, either from the Minuteneſs of the Veſſels thro' which it circulates in the Lungs, or from the Preſſure of the Air upon thoſe Veſſels, or from the Motion of their

Sides, than what happens to it in almoſt every other Part of the Body?

OR, Is there any more Reaſon to ſuppoſe, that the red Globules of the Blood are (if I may be allowed the Expreſſion) ***taken Meaſure of*** in the Lungs, and ſqueezed down to a proper Size to fit the minute Veſſels of the Body, than that in paſſing the minute Veſſels of the Body they are prepared to circulate thro' the Lungs; eſpecially ſince the Blood circulates thro' every Part of a Fœtus, before it is permitted to paſs thro' its Lungs?

YET great Notice is taken of theſe Globules, and great Regard paid to the Preſſure of the Air upon them, and the Motions of the Sides of the Veſſels thro' which they circulate; and the Conſequences of them are ſuppoſed by ſome to be very material: For hence, ſay they, the Blood can, at no two Inſtants of Time, nor in any two Points of the Lungs, be equally preſſed upon; and conſequently, by this Difference of Preſſure, and the great Velocity with which the Blood circulates thro' the minute Blood Veſſels, which are themſelves in perpetual Motion; The old, worn, and broken Globules are ***ſqueezed together***, and ***formed anew***, ***rubbed down***, ***and ground***, ***and turned and twiſted into ſuch Shapes***, as ſuits them beſt (according to the favourite Hypotheſis) to the future Offices of the Circulation.

IT will, therefore, be worth while to remind you of an Experiment of Dr. *Lower*'s; from which it will very plainly appear, that neither this alternate Motion, nor this Difference of Preſſure, is at all neceſſary to the Production of the Arterial Conſtitution of the Blood.

THE Doctor contrived a Way, firſt by making ſmall Inciſions thro' the outward Coat of the Lungs of a living Animal, and then by blowing a continual Blaſt of Air in at the Wind-pipe, to keep the Lungs continually diſtended with freſh Air; and whilſt they were thus without Motion, and conſequently whilſt the Blood circulated without any different Degrees of Preſſure, he opened the Pulmonary Vein, and found the Blood returning in it, as truly Arterial Blood as what uſed to be found in that Vein when the Lungs were ever ſo violently in Motion.

BUT notwithſtanding it appears, that the Action of the minute Veſſels in the Lungs is in itſelf the ſame with the Action of the minute Veſſels in the Body; yet if we reflect upon the different Natures of the Venal and Arterial Blood before they undergo this Action; if we conſider the different Diſcharges which are made from them, whilſt they are undergoing it; and after they have gone thro' it, if we compare the Compactneſs, Elaſticity, and continued Pulſation of the Arteries which receive the Blood at its Return from the Lungs, and convey it to the minute Veſſels of the Body, with the yielding, laxe, and inactive Make of the Veins, which take up the refluent Blood from the minute Veſſels of the Body, and return it again to the Heart; we ſhall not be at all ſurpriſed, that one and the ſame Action ſhould contribute to the different Alterations in the Blood we are now enquiring into.

IF, beſides this, we find that the Blood does, in its Paſſage thro' the Lungs, receive a very conſiderable Supply of thoſe active and nutritious Particles which it loſes in circulating thro' the Body, we ſhall be at no great Loſs to determine for what Uſes they were principally deſigned in the Animal Oeconomy.

1ſt. AS to the different Natures of Venal and Arterial Blood, I ſhall conſider them only in general, and obſerve, that the Arterial Blood is intimately, uniformly, and duly blended together, ſo as to form a Fluid, ſuited to the Offices of the Circulation; and that the Venal Blood is not perfectly ſo, but has loſt ſome of that peculiar Conſtitution, and is approaching to that diſunited State which it ſoon falls into when it is taken out of the Veins and left to itſelf in any Veſſel without Motion.

CONSEQUENTLY, tho' the whole Maſs of Blood, Venal as well as Arterial, is made up of a Number of Fluids, all of different Natures, and is therefore a very heterogeneous Fluid; yet when the Arterial Blood is compared with the Venal, it may allowably enough be termed Homogeneous: becauſe every Portion of Arterial Blood is nearly of the ſame Nature with that which ſucceeds, or that which goes before it; which is not true of the Venal Blood.

WHAT ſtill makes the Fluid which circulates thro' the Lungs more heterogeneous is, that the *Chyle* (which is itſelf an heterogeneous Fluid) is juſt before ſqueezed into the Venal Blood, without being duly and intimately mixed with it.

THE Fluid, therefore, which is to be divided into very minute Streams in its Paſſage thro' the Lungs, compoſed thus of *Chyle* and Venal Blood, muſt, of conſequence, be very heterogeneous; whereas That which is to be ſerved in the ſame manner in the minute Veſſels of the Body, is in this Caſe to be looked upon as homogeneous.

THIS is the firſt remarkable Difference worth our Conſideration.

IN the next Place, we are to conſider the Diſcharges made from theſe different Fluids, whilſt they are thus ſeparated into minute Streams.

THE Diſcharges made from the Arterial Blood may be reduced to theſe general Heads:

1. WHATEVER is ſeparated from the Blood in the Office of Nutrition;

2. WHATEVER paſſes off by inſenſible Perſpiration at the Surface of the Body;

3. WHATEVER in like manner tranſudes thro' the Veſſels into the Cavities of the Body; and

4. WHATEVER is ſecreted from it in any Gland or Viſcus, is taken from the Arterial Blood.

THE firſt of theſe Diſcharges is evidently of ſuch Particles as are of the moſt Advantage to the Health of the Body; and as they are the moſt attractive, they are, without doubt, ſuch as are moſt ſerviceable in keeping up the Arterial Conſtitution.

AS to the Second and Third, tho' they are chiefly of ſuch Particles as are recrementitious, yet, together with theſe, there muſt eſcape ſome of the nutritious Particles; and conſequently, Part of theſe Diſcharges muſt be of diſſervice, and impair the Conſtitution of the remaining Blood.

AND as to the Secretions in general, which are made from the Arterial Blood, the ſame is more remarkably true, both with regard to what nutritious Particles go off with them, and with Regard to the Service moſt of theſe Secretions are afterwards of in ſupplying the Food with ſuch Qualities as make it more readily mix and unite with the Venal Blood, to form it again into Arterial Blood: For the ſame Reaſon, therefore, that theſe Secretions are afterwards of Service in reducing the diſunited Venal Blood and *Chyle* again to the proper Arterial Conſtitution, the Loſs of them muſt be of Diſſervice to the Arterial Blood, and impair its homogeneous Conſtitution; and accordingly we find the Arterial Blood, after every Secretion, even when the Parts ſecreted are excrementitious, brought back in the Veins, as of no farther Service, till it has again been circulated thro' the Lungs.

SO that, in general, the Diſcharges made from the Arterial Blood, tho' they all of them promote the Welfare of the whole Body, are of diſſervice to the Blood itſelf, as to its Arterial Conſtitution, *i. e.* they do all of them, in ſome Degree or other, tend to impair and render it Venal.

ON the contrary, we ſhall find that the Diſcharge made from the Venal Blood and *Chyle*, in their Paſſage thro' the Lungs, is moſt beneficial to the Blood, and greatly promotes the Recovery of its Arterial Conſtitution.

THIS will be very plain, if we conſider it in the following Manner:

UPON examining the Weight of what we eat and drink, and comparing it with the Weight of what we diſcharge by Stool and Urine, we find that much the greater Part of our Food goes off by inſenſible Perſpiration, *i. e.* paſſes off thro' the minute Pores of the Body, and is taken up by the Air in the Form of ſo ſubtle a Fluid as to eſcape our Obſervation.

IN this Account therefore of inſenſible Reſpiration, is included whatever is taken up by the Air, as well in the Lungs as at the Surface of the Body.

WE have already obſerved, that the Air has a free Admittance into the Veſicular Cavities of every the minuteſt Lobule in the Lungs; and it likewiſe appears, from the moſt accurate Eſtimate that has yet been made, or perhaps that the Nature of the Thing will admit of, that the internal Surfaces of all the Veſicles taken together, to which the Air has this conſtant and free Admiſſion, amount to near ten times the Surface of the whole Body.

AS it happens that whenever Perſpiration is much encreaſed, we find a watery Fluid condenſed upon the Surface of the Body; and whenever we open any Part of an Animal, we find it moiſt, and a vapoury Steam ariſing from it, at the ſame time that the red Parts of the Blood are carefully preſerved within the Veſſels; we might ſafely enough conclude, that the exceeding fine Coats of the minute Veſſels in the Lungs will, in the ſame manner, ſuffer theſe watry Parts of the Blood and *Chyle* to eſcape thro' their Pores, without letting the more oily and attractive Particles, which compoſe the red Globules, go off with them.

AND as the Expanſe of Air to which the Blood is here expoſed is ſo much greater than that at the external Surface of the Skin, we might too conclude, that the Diſcharge here muſt be conſiderably greater than at the Skin.

BUT as Experiments are much more convincing than the moſt ſubtle Arguments, I ſhall tranſcribe a few from Dr. *Hales*'s *Hæmaſtaticks* (Page 73—77) by which we ſhall be enabled to form ſome Judgment, both of the Nature and Quantity of this Diſcharge.

" I FIX'D (ſays Dr. *Hales*) a Glaſs Tube to the Pulmonary " Artery of a Calf's Lungs, and then thro' a Funnel poured " warm Water into it; then with a large Pair of Bellows fix'd " to the Wind-pipe, I alternately dilated the Lungs, to try if " by that Means the Water would paſs into the Pulmonary " Vein; but I ſoon found myſelf diſappointed, for the Water " flowed ſo freely from the Capillary Arteries thro' the Tunicles of the Veſicles into the Veſicles themſelves, and thence " into the Bronchia, as to flow plentifully thro' the Wind-pipe, when it hung down in a depending Poſture."

" AT firſt I ſuſpected that the Force of the Water, which " was four Feet high in the Tube affixed to the Artery, might " have burſt the thin Blood-Veſſels; but I found it the ſame " in ſeveral Tryals on the freſh warm Lungs of Sheep, Oxen, " and Calves, even when the perpendicular Height of the Water in the Tube was leſs than a Foot; and doubtleſs the " Force, with which the Blood is thrown into the Lungs by " the right Ventricle of the Heart, is greater than this."

" AND that ſo ſmall a Force of Water could not burſt the " Blood-Veſſels, I was aſſured by the following Experiment, " *viz.* I diſſolved four Ounces of *Nitre* in a Pint of hot Water, into which Water there flowed from the cut Throat of " a Calf, a Quart and a Quarter of a Pint of Blood, which " was kept in a diluted State by the nitrated Water. Having " then fixed a Tube, which was two Feet long to the Pulmonary Artery of the above-mentioned Calf's Lungs, I poured " gradually into the Tube, of the nitrated Blood, as much as " the Artery and its Ramifications would contain, which was

" near a Quart, none paſſing, that I could perceive, into the Pul- " monary Vein."

" THE Lungs were much dilated, and looked very red; " but notwithſtanding the perpendicular Height of the Blood " in the Tube was two Feet, yet no Blood paſſed thro' the " Tunicles of the Veſicles into the Veſicles and Bronchia; for " when the Wind-pipe was held downwards, nothing flowed " out but a white Froth: A plain Proof, that when the Water " was leſs than a Foot perpendicular in Height in the forego- " ing Experiments, it did not forcibly break thro' the Blood- " Veſſels, but muſt paſs thro' Pores, which were too fine for " the Globules of nitrated Blood to paſs."

" WHEN I cut a Slaſh into the Subſtance of the Lungs, the " nitrated Blood flowed freely out."

" AND that the Capillary Veſſels are not burſt by the Force " of the Water, ſeems further probable from hence, *viz.* I " fixed a Tube, five Feet long, to the Pulmonary Vein of a " Hog's Lungs, and poured in warm Water, which neither " flowed into the Pulmonary Arteries, nor among the Bronchia: " an Argument that this Force did not burſt theſe Veins; which, " ſome Anatomiſts ſay, have no Valves in them."

" WHEN I fixed the Tube to the Wind-pipe of thoſe " Lungs, and poured in Water, it paſſed thro' the Bronchia, and " ran out of the Orifice of the Pulmonary Artery; but not " above one fifth ſo faſt, as when its Courſe was the reverſe, " *viz.* from the Pulmonary Artery to the Bronchia; in which " Caſe it run at the Rate of a Pint in a Minute."

" YET when Air was blown into the Cavity of the Lungs " thro' the Wind-pipe, none paſſed thence, either into the " Pulmonary Artery or Vein."

" ANOTHER time I tried alſo, whether the thin Serum of " a Hog's Blood would paſs from the Pulmonary Arteries thro' " the correſponding Veins of the Lungs of the ſame Hog;

" which Lungs were kept warm with Water: the Serum paſ-
" ſed moſt freely thro' into the Bronchia, but not into the Veins."

THUS far Dr. *Hales*.——Now from theſe Experiments it will follow, that what is taken up by the Air in the Lungs is the ſerous Part of the Venal Blood, and the watry Part of the *Chyle*, which is in each of them in too great a Quantity, to be proper for conſtituting Arterial Blood; but that neither the Globular and red Part, which remains unaltered in the Venal Blood, and is ſtill fit to enter the Compoſition of Arterial Blood, nor the common elaſtick Air we breath, is ſuffered to paſs thro' the Coats of the Veſſels.

THE Diſcharge, therefore, which is made from the Venal Blood and *Chyle*, is ſuch as is plainly ſerviceable to the rendering them Arterial Blood.

AS to the Quantity of this Diſcharge, it appears by another Experiment of Dr. *Hales*'s, (Page 323) to which I refer my Reader, " that the Quantity of Moiſture carried off by Reſpi-
" ration in twenty-four Hours, amounts to 1,39 Pound;" which compared with what is, at an Average, ſuppoſed to be perſpired in that time, is $\frac{7}{10}$ of the Whole at leaſt.

THIS Difference, therefore, in the Diſcharges made from the Venal and Arterial Blood, whilſt they undergo the Action of the minute Veſſels of the Body, is likewiſe worth our conſidering.

3dly, ANOTHER Conſideration of great Importance to our preſent Enquiry is, the Supply which the Venal Blood and *Chyle* receive in their Paſſage thro' the Lungs.

FROM the many Experiments which Dr. *Hales* contrived to diſcover the more hidden Properties of the Air, it is very evident, that That Fluid is abſorbed and taken into the very Subſtance of all the other Bodies, whether ſolid or fluid, and whether they are of the Animal, Vegetable, or even the moſt ſolid of the Mineral Tribe: That after it is thus taken into them, it no longer retains its elaſtick Quality, but adheres with the ſtrongeſt Attraction to their component Particles; but that notwithſtanding this, upon the Application of Fire, or upon the Action of any diſſolving Menſtruum, it is always ready to reſume its Elaſticity: and is conſequently, at one time, as ſerviceable in preſerving the Cohæſion of the Parts, as at another time it is active in promoting their Diſſolution, by raiſing too great a Degree of Heat, or producing too violent a Fermentation.

THE Blood in particular, upon being examined by Chemical Experiments, yielded a great Quantity of Air, which before lay inactive within it, and which it muſt certainly have acquired within the Body of the Animal from which it was taken.

THIS naturally led him to try experimentally, Whether this Air paſſes into the Blood with the Aliment only, with which it muſt undoubtedly be mixed, or is any where immediately taken up from the external Air.

HE ſoon found very good Proof, that a great Quantity of elaſtick Air was deſtroyed in Breathing; and tho' it was no eaſy thing to determine exactly the Quantity, yet he contrived a Way of doing it with tolerable Accuracy.

THE Reſult of his Experiment was, that in 24 Hours, when the Air is freſh, a hundred Grains of Air are abſorbed in common Reſpiration.

" BUT (ſays the Doctor) tho' this be not looked upon as a " very exact Eſtimate, it muſt ſtill be allowed, that ſome of " the Elaſticity of the Air, which is inſpired, is deſtroyed, and " that chiefly among the Veſicles, where it is moſtly loaded " with Vapours; whence, probably, ſome of it is conveyed to " the Blood, which we ſee is by an admirable Contrivance " there ſpread into a vaſt Expanſe, commenſurate to a very " large Surface of Air, from which it is parted by very thin " Partitions; ſo very thin, as thereby probably to admit the

" Blood and Air-Particles (which are there continually chang-
" ing from an elaſtick to a ſtrongly-attracting State) within the
" Reach of each other's Attraction; whereby a continued Suc-
" ceſſion of freſh Air may be abſorbed by the Blood."

NOW, if we once allow, that the Air-Particles are taken into the Maſs of Blood, we muſt at the ſame time ſuppoſe them to be as ready to reſume their elaſtick State, and as active in producing Warmth and Heat, whenever the Blood is briskly agitated in the Veſſels of the Body, as they are known to be in any other Subſtances whatever; and for the ſame Reaſon, whilſt they are undiſturbed, to be as ſerviceable in encreaſing the Cohæſion of the Parts they are near, whether ſolid or fluid.

WE may therefore reaſonably conclude, that the Venal Blood and *Chyle* is ſupplied, in their Paſſage thro' the Lungs, with a Quantity of active Particles from the Air.

THE Arterial Blood, on the contrary, does no where, that we know of, receive any ſuch Supply.

THESE are the obvious and remarkable Differences we find upon comparing the Condition of the Blood, whilſt it is changing from Arterial to Venal, with its Condition whilſt it becomes Arterial again; and from theſe Differences, together with the different Natures and Makes of the Veſſels thro' which it circulates, after theſe Changes are begun, it will be eaſy to form a general Notion how the peculiar Conſtitution of the Blood is perpetually preſerved within the Body, whilſt in Health, and what Service the Lungs are of towards it.

IN order to this, it muſt be conſidered in general, that heterogeneous Fluids will retain their peculiar Degrees of Fluidity as long as their component Particles are prevented, either from ſeparating, and afterwards uniting again into different Combinations, by a proper Degree of Heat and Motion, or from flying off, by being encloſed in proper Veſſels.

AND on the contrary, that they will ſoon loſe theſe Degrees of Fluidity, when ſome of their Particles are ſuffered to evaporate, or fly off, and the reſt are left to themſelves without Heat or Motion; whence it will follow, that the longer this remaining Fluid is left to itſelf, and the leſs the Heat and Motion is to which it is expoſed, the more will it degenerate from its former Conſtitution.

IF now we take a View of the Arterial Blood, juſt as it arrives at the ſmall Veſſels of any Part of the Body, and follow it in its Courſe thro' all the Veſſels, to its Return to the Heart and Lungs again, we ſhall find, that at its Entrance into theſe minute Veſſels (tho' it is undoubtedly a very heterogeneous Fluid, compoſed of a Number of Fluids of different Natures, yet they are all ſo intimately, uniformly, and duly blended together, that) every ſucceeding Portion of it is of the ſame Nature with the Portion that goes before it; but that when it arrives at the Heart, its component Fluids are not ſo blended together; different and improper Combinations are beginning; and the Whole is approaching to that diſunited State which it ſoon falls into when taken out of the Body: and, conſequently, that unleſs this diſadvantageous Alteration in the Conſtitution of the Blood be corrected at every Circulation, almoſt as ſoon as it is begun, it would not be long before it become highly improper for the Offices of the Circulation.

THIS will be evident, if we conſider, that in its Progreſs thro' theſe minute Veſſels, the moſt nutritious, and conſequently the moſt attractive Particles, are ſeparated from it in the Office of Nutrition; that other Particles fly off from it in inſenſible Perſpiration; that in ſome Places larger Diſcharges are made from it in Secretion; and that the remaining Fluid is ſeparated into very numerous and minute Streams, which do not unite again till the Blood is brought into one or other of the large Veins, which brings it back to the Heart again.

AND if it be farther conſidered, that theſe large Veins are yielding, laxe, inactive Veſſels, which continually grow wider and wider, and are of a conſiderable length, we may conclude, that the Arterial Blood, like all other heterogeneous Fluids, muſt loſe its peculiar Conſtitution, both on Account of the moſt attractive Parts being ſuffered to eſcape by Perſpiration and Secretion, or being left behind in Nutrition; and on Account of the remaining Part being for a conſiderable time, and in a great Degree, left to itſelf in large inactive Veſſels, with little or no Motion; by which the different ſorts of Fluids, which compoſe the refluent Blood, have liberty given them to ſeparate into different and improper Combinations.

SO that the Blood begins to loſe its Arterial Conſtitution in the minute Veſſels of the Body, and grows more and more depraved the nearer it advances towards the Heart; and when it arrives at it, it is the moſt Venal it is capable of becoming in that particular Circulation.

LET us now, in the ſame manner, take a View of the refluent Blood at its Entrance into the Lungs, and follow it in its Courſe back to the Heart, and thence thro' the Arteries to the minute Veſſels of the Body; and we ſhall find,

1. THAT it receives at the Heart, juſt before it enters the Lungs, a Supply of *Chyle*.

2. THAT this *Chyle* is itſelf a very heterogeneous Fluid, conſiſting of ſuch Particles as are very evidently deſigned by Nature for the Nouriſhment of the Body, blended and mixed with a large Quantity of thin, watery Fluid, by the Intervention of the Saliva, Bile, and Pancreatic Juice.

3. THAT this *Chyle* is not here intimately and duly mixed with the Blood; neither does it continually or equally flow into it; and conſequently,

4. THE ſucceeding Portions of Blood and *Chyle*, which follow each other into the Lungs, are not of one and the ſame Conſtitution.

5. THAT theſe different Portions of Blood and *Chyle* are each of them ſeparated into very numerous and very minute Streams, by the Veſſels which are diſtributed upon the Coats of the Veſicles.

6. THAT by the Inoſculations of theſe minute Veſſels, their heterogeneous Contents are continually and promiſcuouſly running together.

7. THAT whilſt they are circulating within theſe minute inoſculating Veſſels, they have an Opportunity given them, by the Make of the Lungs, and the large Expanſe of Air to which they are expoſed, not only of parting with ſome of the watery and ſerous Particles, with which they are loaded, but of receiving a Supply likewiſe of active and ſtrongly-attractive Particles from the Air.

8. THAT all the Portions of the Blood and *Chyle*, which entered the Lungs of ſuch different Conſtitutions, being there ſeparated into the minuteſt Streams, and continually intermixed with each other; being eaſed of the Load of their watery and inactive Parts; and receiving in their ſtead a Supply of more attractive Particles of the Air: are, after a very ſhort Paſſage, hurried all together thro' four ſmall Veins in Compariſon to the *Venæ Cavæ*, into the left *Sinus*, which conveys them to the Heart of the more lively Colour and uniform Conſiſtence, which is peculiar to Arterial Blood, and which they wanted before.

AND, laſtly, that after they have paſſed the Heart, they are circulated thro' Veſſels which are ſtrong, elaſtick, in continual Action, and grow narrower and narrower; by which Means the due Heat and proper Mixture is kept up and improved in the Blood, till it arrives again at the ſmall Veſſels of the Body, for whoſe Nouriſhment it is purpoſely deſigned.

IT is further to be obſerved, that the Syſtem of Pulmonary Veins, which receive the Blood and *Chyle* thus altered, and newly blended together, is leſs capacious, ſtronger, and more compact, in compariſon to the correſponding Syſtem of Pulmonary Arteries, than any other Syſtem of Veins in the Body is, in compariſon to theirs; and conſequently, tho' they reſemble the other Veins in growing wider and wider, yet by their being ſo ſtrong and compact, as well as by their being ſo much ſhorter, than the other large Veins of the Body; the Blood thus newly mixed will not have the ſame Time or Opportunity allowed it to ſeparate again, and return to its former depraved and broken Conſtitution, in its Paſſage thro' theſe to the Heart, that it had in the others.

THE Blood therefore begins to return to its Arterial Conſtitution in the ſmall Veſſels of the Lungs; and this beneficial Change is kept up, and improved, by the Action of the whole Set of Arteries in the Body.

THUS do we ſee how curious and conſtant a Proviſion is made by Nature to recruit the returning Blood with a freſh Supply of thoſe nutritious and active Particles it muſt neceſſarily part with in every Circulation, and to reſtore that uniform Conſtitution it is ſo liable to loſe during its Return thro' the Veins.

WE ſee likewiſe, that this advantageous Alteration made in the Blood, is not owing to any thing in the Make, Action, or Motion of the minute Blood-Veſſels in the Lungs, different from thoſe in other Parts of the Body; but proceeds,

1. FROM the Situation of theſe Blood-Veſſels, with regard to the Heart, ſo as to be always receiving the refluent Blood, together with what *Chyle* is ready prepared, digeſted, and ſqueezed into it.

2. FROM the Situation, Make, Diſtribution, and Motion of the Air-Veſſels of the Lungs; by which a conſtant Supply of freſh Air is continually admitted into the very inmoſt Receſſes of the Veſicular Cavities.

3. FROM the peculiar Make of theſe Veſicles, the Diſtribution of the minute Blood-Veſſels upon their Coats, and the

Inoſculations among theſe Blood-Veſſels; by which a Communication is made between the Air, the Blood, and *Chyle*, within the Lungs.

AND, laſtly, from the different Nature of theſe Fluids thus brought together, and the Conſequences of their mutual Actions upon each other, both whilſt they are within the Lungs, and whilſt they are circulating thro' the Body by the Force of the Heart and Arteries.

ALTHO' the moſt material Alterations which are made in the Blood may, perhaps, depend upon the mutual Action of component Particles of the Air, Blood, and *Chyle*, upon each other; and we may therefore very reaſonably deſpair of ever being able to form an accurate Idea what theſe Alterations are, or how they are made, any farther than what has already been obſerved in general: yet, as we are certain from Experiment, that there is a conſtant, and very conſiderable, Diſcharge made from the Lungs; as we have Reaſon likewiſe to believe, that a conſiderable Quantity of the elaſtick Particles of the Air is admitted and taken into the Blood itſelf; and as we find ſo abſolute a Neceſſity of a conſtant Supply of freſh Air, that we can live but a very few Minutes without it; it will certainly be worth our while to enquire, with greater Accuracy than we hitherto have done, into the Method in which the deep and inmoſt Receſſes of the Lungs are alternately eaſed of that Air, which is loaded with Vapours, and ſupplied with freſh in its ſtead.

FOR, altho' the Lungs are alternately dilated and contracted, and conſequently ſome Air is alternately admitted into them, and thrown out again; yet as they are never ſo compreſſed as to have all the Air contained within them entirely thrown out, and an equal Quantity of freſh Air admitted in its Place: the Air which lies deepeſt within the Lungs, *viz.* that in the Cavities of the Veſicles will not be thrown out at all by their alternate Motion; for upon the Contraction of the Lungs, it will be only puſhed up higher into the larger Branches of the Bronchia, and upon their Dilatation it will fall down again into the ſame Cavities, and conſequently from this alternate Motion of the Lungs alone, we can account for no more than a conſtant Supply of Air ſomewhere within the larger Air-Veſſels: but for the continual Change of Air in the Veſicular Cavities, which is the only Place where it is of immediate Service, we muſt have recourſe to ſome other Cauſe.

THIS other Cauſe is the elaſtick Quality of the Air, by which it is always obſerved to expand itſelf, and conſequently become lighter, as it acquires different Degrees of Heat; and to condenſe and grow heavier, as it loſes them again. The Conſequence of which is, that almoſt as ſoon as any Air is admitted into the Lungs, it acquires a certain Degree of Heat above what it had before; by which it expands, and becomes lighter than common Air, and muſt, for that Reaſon, aſcend and go out of the Lungs, and give room for the freſh and heavier Air to ſubſide into its Place: and as the Veſicles lie the deepeſt within the Lungs; as the Air within them is almoſt in immediate Contact with the Blood; and as there is continually oozing thro' their Coats a watery Vapour, warm as the Blood it is immediately taken from: it will plainly follow, that the Air within theſe Cavities is the warmeſt and moſt dilated of any Air within the Lungs; and conſequently will be continually aſcending thro' the cooler and freſher Air, whilſt that deſcends into its place: So that by this Circulation among the different Portions of Air within the Lungs, a freſh Supply of it is admitted into the Veſicular Cavities, and the watery and recrementitious Vapour diſcharged from the Blood, are conveyed away with the warmer Air which is expired.

IF with this View we again take the Fabrick of the Air-Veſſels of the Lungs into Conſideration, and compare the Make and Situation of the Air-Pipe and Bronchia, with the Make and Situation of the very minute Veſicles, we ſhall find the firſt of theſe particularly contrived to promote an eaſy Circulation among theſe different Portions of Air.

THE Wind-Pipe, the Bronchia, and the larger Branches of them, are plainly of a very ſtrong cartilaginous Make, which reſiſts the Preſſure of the Parts about them; ſo that they are always (in Expiration as well as Inſpiration) nearly of the ſame Capacity; and this ſort of Make is continued, in a great Meaſure, thro' all, even the very minute Branches of the Bronchia. On the contrary, the Veſicles are of ſo fine a Contexture, that they yield to every the ſmalleſt Preſſure, and are ſo ſituated towards the external Parts of the Lungs, that they are more immediately preſſed upon by the Air in the Cavity of the Breaſt, than even the ſmall Branches of the Bronchia are; and conſequently muſt have their Cavities very conſiderably diminiſhed during every Expiration.

SO that we may in general affirm, that the Capacity of all the Veſicular Cavities taken together, will be very conſiderably diminiſhed in every Expiration, in proportion to its Magnitude; and the Capacity of all the larger Air Veſſels will not, in proportion to its Magnitude.

FROM this, therefore, it ſhould ſeem, that the Veſicular Part of the Lungs, and the very minuteſt Branches of the Bronchia, are more particularly affected by the alternate Motions of the Ribs and Diaphragm; and the Wind-Pipe and Bronchia (with regard to Reſpiration) are of no other Service, than to receive both the freſh and the old Air, and afford them convenient room to change Places according to their particular Gravities.

FOR the warm Air, when it is, by the Contraction of the Breaſt, ſqueezed out of the Veſicular Cavities into the Bronchia, has there Liberty given it to circulate; and by that time the Breaſt has dilated again, it has aſcended thro' the freſher Air;

which freſher Air, being deſcended into its Place, ſtands ready to ſupply the dilating Veſicles.

THUS may we account, with a tolerable Degree of Probability, as well as Accuracy, for the Manner in which both the Diſcharge made from the Blood in the Lungs is carried off with the warm Air, and the Supply of freſh Air is taken into the Veſicles in its Place; and if we conſider, that this is continually doing, without any the leaſt Interruption when we are in perfect Health, we may eaſily conceive how ſo great a Diſcharge may be made, tho' in the Form of a Fluid too ſubtle to be the Object of our Sight.

I HAVE dwelt the longer on this Subject, and been more particular in explaining this Nicety in the Manner of our Breathing, becauſe it will greatly aſſiſt us in forming a Judgment of what ſeems at preſent the moſt probable way of accounting for the abſolute Neceſſity we are under of having a conſtant Supply of freſh Air.

IN order to ſettle this Point, ſeveral have tried Experiments, both on themſelves, as long as they could bear them; and on Animals, till they expired. They themſelves found the greateſt Uneaſineſs in breathing the ſame Air after two or three Minutes; and the Animals all of them died, tho' ſome lived much longer than others.

THE ſame ſort of Experiments were tried with burning Candles, lighted Brimſtone, *&c.* confined to the ſame Air, in a large Receiver; and Flame, as well as Life, was found to ſubſiſt no longer than freſh Air was admitted to its Support.

HENCE thoſe, who firſt made theſe Experiments, imagined that there were certain Particles, friendly to Life and Flame, equally diſtributed in every Portion of Air; and that when theſe were exhauſted, either by the Breathing of an Animal, or the Flame of any burning Subſtance, That Portion of Air became entirely uſeleſs; and unleſs another freſh one, with its Recruit of friendly Particles, was admitted, the Animal died, and the Flame went out. Theſe were afterwards ſuppoſed to be nitrous Particles; and accordingly That Air was eſteemed the moſt healthy which abounded moſt with Nitre.

BUT when Dr. *Hales*, in his *Analyſis of the Air*, repeated theſe Experiments, with ſome little Difference in the Manner of making them, he ſoon found good Reaſon to ſuſpect the Inſufficiency of this way of accounting, either for the Death of the Animals, or the going out of the Flame.

HE added to theſe, ſeveral new Experiments of his own; and from the Whole, he was rather inclined to believe They were owing to the Loſs of Elaſticity in the component Particles of the Air itſelf; which he found, by his Experiments, always followed upon admitting either the Smoak of burning Candles, Brimſtone, &c. or the Vapours exhaled along with the Breath of living Animals, into the Air confined in a Receiver. *Vide* the Experiments, and the Reaſoning upon them, from *Exp.* 102. to the End of the *Analyſis of the Air*, in the *Vegetable Staticks*.

AS there is ſome Nicety in this way of accounting for the Death of Animals, which are long confined to breath the ſame Air; and conſequently, for the great Uneaſineſs any Perſon feels upon attempting to do the ſame for more than a Minute or two; and as what the Doctor has ſaid upon this Subject is diſperſed about in ſeveral Parts of his Two Volumes; I hope I ſhall be excuſed, if I collect all that can be ſaid upon it, and ſet it in one View; in order that it may be the more readily embraced, if it be true, or more eaſily confuted, if it be falſe.

HE tells us in his *Appendix* to the *Hæmaſt.* p. 323, that he made Uſe of the following Method to try, with the greateſt Eaſe and Accuracy, how long he could breath, to and fro, the ſame Air, and to find how much of its Elaſticity was in that Time deſtroyed.

"I CEMENTED (ſays he) faſt at a Hole in the Top of an "Air-Pump Receiver, a Wooden Foſſet. I ſet this Receiver "in a wide Veſſel, which had two Inches depth of Water in it, "leaving room at the Bottom for the Water to paſs freely to "and fro. In this Poſition, the Quantity of Air in the Re- "ceiver was equal to 522 Cubick Inches. Then, ſtopping my "Noſtrils, I firſt breathed out what Air I could from my "Lungs, and then applied my Mouth to the End of the Foſ- "ſet, where I breathed to and fro the 522 Cubick Inches of "Air for two Minutes and a half; when growing uneaſy, I "breathed all the Air I could from my Lungs, as at the firſt; "and at the ſame time giving a Signal to a Stander-by to mark "the Height of the Water in the Receiver with a Piece of "Chalk, I found upon meaſuring, that 18 Cubick Inches, or "$\frac{1}{29}$th Part of the whole Air, was in that Time reduced from "an elaſtick to a fixed State: But ſome further Allowance is "to be made on Account of the Expanſion of the Air in the "Receiver, by reaſon of the Heat it had received in Reſpira- "tion."

UPON this Experiment we may make the following Obſervations.

1. WHILST the Air, included within the Receiver, was freely taken in, and thrown out of the Lungs, there was continually admitted into it what Vapours were exhaled from the Veſicular Cavities of the Lungs, and thro' the Coats of all the Parts between the Lips and thoſe Veſicles.

2. NONE of the Particles of included Air and Vapour have any Means to eſcape thro' the Glaſs or Water; nor is it to be ſuppoſed, that in ſo ſhort a time as two or three Minutes, any conſiderable Quantity of them could be abſorbed and taken into the Blood; and,

3. CONSEQUENTLY, the Receiver, Mouth, Throat, and Lungs do, at the End of that Time, contain all the Particles of

Air which they contained at firſt, together with the Vapours exhaled into them.

4. SINCE the Water riſes in the Receiver, by the Preſſure of the external Air upon the Surface of the Water in the large Veſſel, theſe Particles muſt lie cloſer together than they did before, without preſſing more upon the Water than when they had the whole Receiver to poſſeſs.

5. CONSEQUENTLY, either every Particle of Air muſt have loſt Part of its Elaſticity, or Part of them have loſt it all, and have entirely changed from an elaſtick repelling Condition to a ſtrongly attracting one.

6. SINCE the Water (in other Experiments tried in the ſame manner) is found to riſe after the Receiver, and Air, and every thing is cool, and left to itſelf; it ſeems reaſonable to conclude, that the Vapours exhaling from the Lungs do ſo ſtrongly attract the Particles of the Air, in which they ſwim, as to incorporate with them, and prevent their flying off, and becoming elaſtick again.

7. FROM what was ſaid above, Reſpiration is beſt carried on when the Air we breath is perfectly elaſtick, and when That Portion of it, which is to be taken into the Lungs, is of a proper Degree of Coolneſs, in compariſon to the Warmth of the Vapours exhaled from the Blood into the Veſicular Cavities; becauſe the free Circulation of the Air in the Lungs depends entirely upon theſe Properties of the Air.

8. IN this Experiment, therefore, the oftener the Portion of Air, contained in the Receiver, has been breathed to and fro, and paſſed thro' the Veſicular Cavities of the Lungs, it will not only be more and more loaded with Vapours, which we find by Experience deſtroy its Elaſticity, but it will likewiſe come nearer and nearer to the ſame Degree of Warmth with the Air in thoſe Cavities; and conſequently, will loſe more and more of thoſe Properties, Coolneſs and Elaſticity, upon which the Cir-

culation of the Air within the Lungs depends, and by which the Air is perpetually changing in ordinary Reſpiration.

9. IT is evident, therefore, from this way of Reaſoning, that there muſt be a Time after which the Air in the Veſicular Cavities can no longer be changed for the Air in the Receiver.

10. THIS Time appears, from this Experiment, to be about three Minutes in human Lungs: for it is reaſonable to ſuppoſe, that the Uneaſineſs in breathing ariſes wholly from the Want of this Change of Air in the Lungs; which I am now to ſhew.

Dr. *Hales* expreſſes himſelf thus, in *Exp.* 111. *Veget. Stat.* "It is plain, from the Effects of the Fumes of burning Brim-" ſtone, lighted Candles, and the *Breath of Animals*, on the "Elaſticity of the Air, that its Elaſticity in the Veſicles of the "Lungs muſt be continually decreaſing, by reaſon of the Va-" pours it is there loaded with; ſo that thoſe Veſicles would, "in a little time, ſubſide, and fall flat, if they were not fre-" quently repleniſhed with freſh elaſtick Air at every Inſpira-" tion, thro' which the inferior heated Vapour and Air aſcends, "and leaves room for the freſh Air to deſcend into the Veſi-" cles."

"BUT when, inſtead of theſe frequent Recruits of freſh "Air, there is inſpired an Air ſurcharged with acid Fumes and "Vapours, which not only, by their Acidity, contract the exqui-" ſitely ſenſible Veſicles, but alſo, by their Groſsneſs, much re-" tard the free Ingreſs of the Air into the Veſicles; many of "which are exceeding ſmall, ſo as not to be viſible without a "Microſcope; which Fumes are likewiſe continually rebating "the Elaſticity of that Air: then the Air in the Veſicles will "loſe its Elaſticity very faſt, (*Vide* Exp. 107, 108.) and, con-" ſequently, the Veſicles will fall flat, notwithſtanding the En-" deavours of the extending Thorax to dilate them as uſual; "whereby the Motion of the Blood thro' the Lungs being "ſtopped, inſtant Death enſues."

" WHICH ſudden and fatal Effect of theſe noxious Vapours " has hitherto been ſuppoſed to be wholly owing to the Loſs " and Waſte of the *Vivyfying Spirit of Air*, but may not " unreaſonably be alſo attributed to the Loſs of a conſiderable Part of the Air's Elaſticity, and the Groſsneſs and Denſity of the Vapours which the Air is charged with; for mutually attracting Particles, when floating in ſo thin a Medium as the Air, will readily coaleſce into groſſer Combinations: which Effect of theſe Vapours, having not been duly " obſerved before, it was concluded, that they did not affect " the Air's Elaſticity; and that, conſequently, the Lungs muſt " needs be as much dilated in Inſpiration by this, as by a clear " Air.

" BUT that the Lungs will not riſe and dilate as uſual, when " they draw in ſuch noxious Air, which decreaſes faſt in its " Elaſticity, I was aſſured, by the Experiment I made on my " ſelf, in *Exp*. 107; for when, towards the latter End of the " Minute, the ſuffocating Quality of the Air in the Bladder " was greateſt, it was with much Difficulty that I could dilate " my Lungs a very little."

IN our preſent Experiment, the Air in the Receiver is loaded with no other noxious Vapours than what are exhaled from the Lungs in Reſpiration; but after this Air is become ſo warm, and has loſt ſo much of its Elaſticity, that it can no longer circulate, and by that Means paſs into the Veſicular Cavities, the Air, which remains there unchanged for freſher Air, muſt be continually loaded with more and more of theſe Vapours; which we know will deſtroy the Elaſticity the faſter, the greater the Proportion is which they bear to the Air which ſuſtains them.

AND if it be true, as Dr. *Hales* ſuſpects, that mutually attracting Particles, floating in ſo thin a Medium as Air, will very readily coaleſce into groſſer, and ſtill groſſer Combinations: is it unreaſonable to ſuppoſe, that at laſt theſe Combinations will be too groſs to paſs from the Branches of the Bronchia, into which they are ſqueezed in Expiration, back again into the exceedingly minute Veſicles?

AND will not the Air, remaining ſtill behind, within the Veſicles continue loſing more and more of its Elaſticity?

AND when no more Air can enter to dilate the Veſicles, will not the Weight of the external Air, upon the Abdomen, force the Diaphragm up into the Cavity of the Thorax? Will not this compreſs the Air in that Cavity? And the Air in the Cavity, of courſe, compreſs the Veſicular Parts of the Lungs, which it immediately ſurrounds; till at laſt all the Veſicles become ſo flatted and ſqueezed together, as to prevent the Blood from circulating thro' the Veſſels diſtributed upon their Coats?

IS not the Conſequence of this laſt State, certain and immediate Death? And when, in this Experiment, the Air had been breathed between two or three Minutes, and the Air within the Lungs was continually approaching nearer and nearer to the State deſcribed above, Was not the great Uneaſineſs felt in continuing to breath this Air, the Conſequence of the Veſicles beginning to collapſe, and the Blood's beginning to circulate with Difficulty? At leaſt, Is not this the moſt reaſonable Way of accounting for this Uneaſineſs?

IT HAS BEEN OBJECTED, I know, that the Water which riſes into the Receiver (by compreſſing the Air contained within it and the Lungs) keeps it always of the ſame Degree of Elaſticity with the external Air; and conſequently, that the Lungs are as much preſſed within by this Air, as they would be by the freſh external Air; and conſequently, that they may as eaſily be dilated by one as the other.

TO this it may be anſwered, that perhaps the inner Surface of the Wind-pipe and Bronchia may be preſſed as much by this Air, as the external Surface of the Lungs is by the Air in the Cavity; but if the Air in the Bronchia, loaded ſo with Vapours, cannot enter the Veſicular Cavities, then the ***internal Surfaces of the Veſicles*** are not equally preſſed with their ***external***; and conſequently, as the Preſſure within is continually decreaſing, whilſt that without continues the ſame, the external Preſſure will ſoon occaſion great Uneaſineſs, and ſoon after Death itſelf.

IT HAS BEEN OBJECTED too, that Air leſs elaſtick and more loaded with Vapours, than that in the Receiver, even at the End of the Experiment, is often breathed without occaſioning ſuch Uneaſineſs, as the Doctor felt in making this Experiment.

TO this it may be anſwered, that the Air in the Receiver is no otherwiſe the Occaſion of the Uneaſineſs in breathing, than as it prevents that Circulation upon which the Change of Air in the Veſicles depends; and perhaps Air leſs elaſtick and more loaded with Vapours, if thoſe Vapours were cooler, might not do ſo.

THE Air in the Receiver is loaded with Vapours of the ſame ſort, and has loſt Part of its Elaſticity in the ſame manner with the Air in the Veſicles, and the ſmall Branches of the Bronchia, but not in the ſame Degree; and, perhaps, if the Veſicles could be conſtantly ſupplied with no freſher Air, than that in the Receiver, ſo as not to have it continue long enough in them to grow worſe and denſer, and more loaded with groſs Combinations, Reſpiration might go on without any very great Uneaſineſs. But this the Circumſtances of the Experiment will not admit of.

IT ſeems reaſonable to believe this, from the 114th Experiment of Dr. *Hales*, *Veget. Stat.*

" I TYED, ſays the Doctor, a middle-ſized Dog alive on the
" Table, and having laid bare his Wind-pipe, I cut it aſunder
" juſt below the ***Larynx***, and fixed faſt to it the ſmall End of
" a common Foſſet, the other End of the Foſſet had a large
" Bladder tyed to it, which contained 162 Cubick Inches; and
" to the other End of the Bladder was tyed the great End of

" another Foſſet, whoſe Orifice was covered with a Valve, " which opened inward, ſo as to admit any Air that was blown " into the Bladder, but none could return that Way; yet, for " further Security, that Paſſage was alſo ſtopped with a Spig- " got."

" AS ſoon as the firſt Foſſet was tyed faſt to the Wind-pipe, " the Bladder was blown full of Air thro' the other Foſſet. " When the Dog had breathed the Air in the Bladder to and " fro for a Minute or two, he then breathed very faſt, and " ſhewed great Uneaſineſs, as being almoſt ſuffocated."

" THEN with my Hand I preſſed the Bladder hard, ſo as " to drive the Air into his Lungs with ſome Force, and there- " by make his *Abdomen* riſe by the Preſſure of the *Diaphragm*, " as in natural Breathings; then taking alternately my Hand " off the Bladder, the Lungs with the *Abdomen* ſubſided."

" I CONTINUED in this manner to make the Dog breathe for " an Hour; during which time I was obliged to blow freſh " Air into the Bladder every five Minutes, three Parts in four " of that Air being either abſorbed by the Vapours of the " Lungs, or eſcaping thro' the Ligatures, upon my preſſing " hard on the Bladder."

" DURING this Hour, the Dog was frequently *near ex-* " *piring* whenever I preſſed the Air *but weakly* into his Lungs, " as I found by his Pulſe, which was very plain to be felt in " the great *Crural* Artery near the Groin; but the languid " Pulſe was *quickly* accelerated ſo as to beat *faſt* ſoon after I " dilated the Lungs *much by preſſing hard* upon the Bladder, " eſpecially when the *Motion of the Lungs was promoted* by " preſſing alternately the *Abdomen* and the Bladder, whereby " both the Contraction and Dilatation of the Lungs was encrea- " ſed."

" AND I could, by *this Means*, rouſe the languid Pulſe " *whenever I pleaſed*, not only at the End of every five Mi-

" nutes, when more Air was blown into the Bladder from a " Man's Lungs, but alſo *towards the End of the five Minutes, when the Air was fulleſt of Fumes.*"

" AT the End of the Hour, I intended to try, whether I " could, by the ſame Means, have kept the Dog alive ſome " time longer, when the Bladder was filled with the Fumes of " burning Brimſtone: But being obliged to *ceaſe for a little* " *time from preſſing the Air into his Lungs*, while Matters " were preparing for this additional Experiment, in the mean " time the Dog died, which might otherwiſe *have lived longer*, " *if I had continued to force the Air into his Lungs.*"

" NOW, tho' this Experiment was ſo frequently diſturbed, " by being obliged to blow more Air into the Bladder twelve " times during the Hour; yet ſince he was almoſt ſuffocated in " leſs than two Minutes by breathing *of himſelf* to and fro the " firſt Air in the Bladder, he would (by Experiment 106, on " Candles) have *died in leſs than two Minutes*, when one " fourth of the old Air remained in the Bladder, immediately " to taint the new admitted Air from a Man's Lungs; ſo that " his continuing to live thro' the whole Hour, muſt be owing " *to the forceable Dilatation of the Lungs by compreſſing the* " *Bladder*, and *not* to the *Vivifying* Spirit of the Air; for " without that forceable Dilatation, he had, after the firſt five " or ten Minutes, been certainly dead in leſs than a Minute, " when his Pulſe was ſo very low and weak; which I did not " find to be revived barely by blowing three Parts in four of " the new Air from the Lungs of a Man into the Bladder: " But it was conſtantly rouſed and quickened, whenever *I encreaſed the Dilatations of the Lungs by compreſſing the* " *Bladder more vigorouſly*; and that whether it was at the " Beginning, or End of each five Minutes: yet it was more " eaſily quickened, when the Bladder was at any time newly " filled, than when it was empty."

HENCE it appears, that altho' the Air in the Bladder was ſo much loaded with Vapours, that the Animal muſt have expired in a Minute after the firſt five or ten Minutes, if it had been left to itſelf; yet the meer ſqueezing this Air forceably into its Lungs, did immediately revive its languid Pulſe, and the conſtant Repetition of it preſerved it from expiring for an Hour, which even the Admiſſion of the freſh Air, every five Minutes, could not have done. Now, the only Effect of ſqueezing the Air thus forceably into the Lungs, that we know of, is dilating their Veſicles, and giving room for the Blood to circulate freely thro' them; and conſequently, we may ſafely conclude, that the languid Pulſe, and the approaching Death of the Animal, was owing entirely to the Veſicles collapſing very faſt, for want of elaſtick Air within them to keep them ſufficiently dilated.

AND by Parity of Reaſoning, the great Uneaſineſs which the Doctor felt at the End of his Experiment, was owing entirely to the Want of Change in the Air within the Veſicular Cavities of his Lungs; which we have ſhewn muſt be the Conſequence of his Experiment.

THERE remains only one Point to be ſettled, before we conclude this Lecture, and that is in what manner the Particles of Air are taken into the Blood: and after what has been ſaid, we ſhall find no great Difficulty in it.

FOR if we conſider, that at the Surface of the Body there are not only Pores, thro' which the perſpirable Matter paſſes out, but others alſo, which are ready to imbibe the Moiſture which is near them; and that in all the Cavities of the Body there muſt be abſorbing Veſſels to take up the Vapours, which are continually exhaled into them, in order to prevent their increaſing to ſuch a Degree as to occaſion a Diſeaſe; we may reaſonably conclude, that there are ſimilar abſorbing Veſſels in the Veſicles of the Lungs.

CONSEQUENTLY in a healthy State of the Lungs, whilſt a perfect Reſpiration is kept up; and whilſt there is continually oozing thro' the Coats of the Veſicles a Vapour, which we know from Experiments attracts the Particles of Air, incorporates with them, deſtroys their elaſtick Quality, and keeps them in a ſtrongly attracting State; Part of this Vapour muſt be ſucked in by theſe abſorbing Veſſels, and carried into the Blood, and circulated all over the Body; and together with it, the Particles of Air thus abſorbed, and taken into it: which could not, in their elaſtick State, have found Admittance.

I SHALL now conclude with the following Queries, which I ſubmit to a further and more mature Conſideration.

DOES not the Blood contain the Particles, which are deſigned by Nature for the Nouriſhment of the Body, and which are to be conveyed by the Circulation to every Part of it?

DOES not the Blood in the Arteries abound moſt with theſe nutritious Particles? And, are not the different Fluids which compoſe it, ſo well blended and mixed together, that it is every where alike, and of a due Conſiſtency to paſs thro' the minuteſt Veſſels of the Body?

DOES not the Blood begin to loſe this its Arterial Conſtitution in theſe minute Veſſels of the Body, and grow more and more depraved, the further it advances towards the Heart in the large Veins? and when it arrives at the Heart, is it not the moſt broken and diſunited that it is capable of being in that particular Circulation?

IS not this its broken Conſtitution at the Heart owing, firſt, in general, to its moſt attractive Particles having eſcaped in Perſpiration and Secretion, or having been left behind in Nutrition; and to the remaining Fluid's having been for a conſiderable Time, and in a great Degree, left to itſelf in large inactive Veſſels, with little or no Motion; by which the different Fluids which compoſe it have had Liberty given them to ſeparate into diſtinct and improper Combinations? And, ſecondly, in particular, to the Heart's being ſo ſituated as to receive at one and at the ſame time the refluent Blood, both from the ſuperior Parts of the Body, juſt after the Chyle is ſqueezed into it, and from the inferior Parts, juſt after it has received the Blood from the Liver, without either of theſe being duly mixed and blended with it; which Blood coming immediately from the Liver, may reaſonably be ſuppoſed to be the moſt broken of any of the refluent Blood, becauſe it has not only gone thro' the Office of Nutrition in its Arterial State, but even in its Venal State has had the Bile ſecreted from it, and conſequently has parted with that Fluid which mixes the beſt with the other Fluids in the Blood, and unites and keeps them blended together in one uniform Maſs?

MUST not this broken and diſunited Blood, if it was to continue without any Recruits of attractive and nutritious Particles, or without having its component Fluids more intimately blended and mixed together, return to the Heart, after every Circulation, more and more depraved and diſunited; and at laſt become utterly unfit for the Purpoſes of Life?

DOES not the refluent Blood, therefore, immediately before the Heart tranſmits it to the Lungs, receive a Supply of Chyle, prepared by Nature for the Nouriſhment of the Body, tho' it is loaded with a conſiderable Quantity of watery and recrementitious Particles?

AND whilſt this Chyle and refluent Blood are circulating thro' the Lungs, Are not the different Fluids, which compoſe them, continually and promiſcuouſly mixed and blended together, by the numberleſs Inoſculations amongſt their minuteſt Blood Veſſels?

AND whilſt they are thus mixing together, Is there not continually oozing into the Veſicular Cavities, a Vapour compoſed of their moſt watery, ſerous, and recrementitious Particles?

IS not this Vapour of ſuch a Nature, as to abſorb and take into it the elaſtick Particles of the Air, admitted into thoſe Veſicular Cavities?

DO not theſe Particles of Air, thus abſorbed, loſe their Elaſticity, become ſtrongly attractive, and adhere cloſely to the component Particles of this Vapour?

IS not one Part of the Vapour, with the Particles of Air taken into it, ſupported in, and carried off, by the warmer Air we breath out at the Mouth and Noſtrils?

AND is not the other Part of it, with its ſhare of Air Particles, taken into the Blood again by the abſorbent Veſſels in the Coats of the Veſicles?

IF we once allow, that the Particles of Air are taken into the Maſs of Blood, muſt we not at the ſame time ſuppoſe them to be as ready to reſume their elaſtick State, and as active in producing Warmth and Heat, whenever the Blood is briskly agitated in the Veſſels of the Body, as they are known to be in other Subſtances, in which they lie abſorbed; and for the ſame Reaſon, whilſt they are undiſturbed, to be as ſerviceable in increaſing the Cohæſion of the Parts they are near, whether ſolid or fluid?

ARE not the red Globules, which ſwim in the thinner Fluid of healthy Blood, known to retain their Globular Form only from their Parts cohæring more ſtrongly to one another, than to the ſerous Part of the Blood? And, may they not therefore be looked upon as the moſt attractive and powerful Part of the Blood?

AND ſince Water is the leaſt ſuſceptible of Heat, from Friction, of any Fluid which enters the Compoſition of Blood, can it be the ſerous? Is it not rather the Globular red Part of the Blood, which firſt acquires and chiefly produces Heat by the Force of the Circulation?

FROM this, compared with what was ſaid before, is it too chimærical to ſuppoſe, that the Particles of Air, thus abſorbed, and taken into the Blood, do, in their Progreſs thro' the Lungs and the larger Arteries of the Body, mix with the Maſs of Blood and Chyle; and joining themſelves to the moſt attractive Part of them, form together, by their mutual Attraction, the Globular red Part of the Blood, which, by the Force of the Circulation, and the Friction of the Parts, keeps up that natural Warmth which is ſo neceſſary to the well-being of the whole Body?

AND as the Velocity of the Blood is found to be greater in the Lungs, than in any other Part of the Body, would not this Heat be more remarkably felt in this Part, if the conſtant Acceſſion of cool Air did not continually temper, and keep it pretty nearly at a Par with that of the other Parts?

ARE not the Lungs, therefore, contrived, and ſituated as they are, that the refluent Blood may, as it paſſes thro' them, be gradually recruited with the active and nutritious Particles it is continually loſing in the Offices of the Circulation, and at the ſame time relieved from the improper Combinations its component Fluids may have fallen into in its return thro' the Veins, by a conſtant Diſcharge of the moſt watery and ſerous Parts of them in the Air we breath, and by the remaining Fluids being duly and intimately mixed with the freſh Supplies of Chyle and Air?

IS not the Uſe of Reſpiration, in the Animal Oeconomy, to promote the Diſcharge of the recrementitious Particles, and to ſupply the Blood with more active and beneficial ones in their ſtead?

IS not the Air we breath the Means of conveying away the Vapour exhaled from the Lungs? And, is not that Vapour, in its turn, the Means of conveying the Supply of Air into the Blood? And, could either of theſe be effected without their mutual Action upon each other?

ARE not the Veſicular Cavities of the Lungs the Seat where theſe neceſſary Works are continually carried on, as the Condition of the Body requires? And, are they not moſt conveniently ſituated for this Purpoſe, out of the immediate Influence of the common Inclemencies of the Weather? And, laſtly, are not the regular Returns of Expiration and Inſpiration perpetually kept up, in order to remove the warmer Air, loaded with Vapours, into the larger Branches of the Bronchia, where it has room to circulate thro' the cooler and heavier Air taken in at the Wind-pipe; and to receive this freſher Air in its ſtead: by which the Air in thoſe Cavities is never allowed to loſe too much of its Elaſticity, and the Vapours exhaled from the Lungs are prevented from forming themſelves into too groſs Combinations, and ſo overcharging, and at laſt ſtopping up, the Entrance into the Veſicular Cavities; the Conſequence of which we have ſeen would very ſoon be fatal?

THIS is all I have to offer on the Uſe of Reſpiration, and the Office of the Lungs, in the Animal Oeconomy: And, if I have any where given too much Way to Conjecture, I hope it will be imputed to the Nicety of the Subject, and minute Structure of the Parts, which will not admit of that Variety of Experiments, which may be neceſſary to a thorough Conviction.

LECTURE III.

OF THE

Diſeaſes *of the* ORGANS *of* RESPIRATION.

WHEN we are in Health, and Reſpiration is carried on in the beſt and moſt perfect Manner, the Cheſt is alternately raiſed, and depreſſed; the Abdomen ſwells, and ſubſides; and the Air is breathed in and out through the Mouth and Noſtrils with Eaſe, Conſtancy, and a ſort of Pleaſure: and theſe Motions are performed with the ſame Freedom in moderate Exerciſe, as when we are at Reſt.

NOW as theſe Motions have been ſhewn to be the natural Conſequences of the Make of the Cheſt and Abdomen, and of the alternate Actions of the Muſcles deſcribed above, as well as of the Make and Situation of the Lungs themſelves, and the Nature of the Air we breath; it will follow, that the regular, conſtant, and eaſy Performance of them is an Indication of the Health and proper Action of all the Parts concerned in Reſpiration.

FOR the ſame Reaſon, when either there is ſome wrong Formation of any of theſe Parts, or they have received any accidental Injury; when their Actions are any ways diſturbed, or when the Air itſelf is not of a due Coolneſs or Elaſticity; the Eaſe, Conſtancy, and Regularity, of theſe outward Appearances in Reſpiration will be proportionably diſturbed, and differently affected, as this or that Part is prevented from performing its Share in the Action of Reſpiration; and theſe external Appearances ſo diſturbed, are the Symptoms attending upon the Diſeaſes of the Organs of Reſpiration, and the neceſſary Conſequences of the imperfect Actions of theſe Organs ſo diſeaſed.

WE ſhall in this Lecture, therefore, take a Review of all the different Parts deſcribed above, and conſider them in a different Light from what we did before, in order to point out what particular Changes in the outward Appearances will follow upon any Diſeaſe in one or more of them.

SUCH a Review will not only be of Service to us in deducing the Seat of any Diſeaſe from the Symptoms which attend upon it, and conſequently in directing us to the Method we ought moſt reaſonably to follow in our Attempts to remove it; but it will likewiſe aſſiſt us in our Philoſophical Enquiries into this Part of the Animal Oeconomy.

FOR ſince the Symptoms which attend any Diſeaſe are the true and neceſſary Conſequences of the imperfect Actions of the Parts, whilſt they are diſordered; they may be derived from the particular Diſorders to which they are owing, provided we are ſufficiently acquainted with the true Make of the Parts, and all the Requiſites to their acting properly: and conſequently, ſo far as we are able, from the Seat and firſt Cauſe of a Diſeaſe to derive the Symptoms which attend it, ſo far, and no farther, may we depend upon the Goodneſs of our Theory of the Animal Oeconomy.

EVERY Diſeaſe, therefore, with its Train of Symptoms, conſidered in this Light, is a ſort of Experiment offered us by Nature herſelf, by which we may fairly try how far our Knowledge extends, and whether the Notions we have entertained in our Attempts to explain the Animal Oeconomy are well or ill grounded, and conſequently whether they are to be retained or rejected.

LET us now begin this Review; and whilſt the particular Diſorders of any one or more of the Parts concerned are under Conſideration, let us ſuppoſe the others perfectly in Health, and properly conſtructed.

FIRST, we have ſeen the Neceſſity there is for the alternate dilating and contracting of the Cavity of the Breaſt; and that it is performed, partly by the Action of the Intercoſtal Muſcles, which alternately raiſe and depreſs the Ribs, and partly by the Action of the Diaphragm and Abdominal Muſcles, which alternately force the Contents of the Abdomen into and out of that Cavity.

WHEN we are in Health, and Reſpiration is carried on without our attending to it, both theſe Sets of Muſcles perform their proper Shares in enlarging and contracting the Cavity of the Breaſt: But however, we can, if we pleaſe, hold the Ribs fixed, and ſufficiently enlarge and contract it, by the Actions of the Abdominal Muſcles and Diaphragm only; and in the ſame manner, tho' not in ſo great a Degree, we can lay the Labour upon the Intercoſtal Muſcles.

WHAT we can thus perform at our Pleaſure, when in Health, we experience to be of Service, when either of theſe Sets of Muſcles are diſeaſed and in pain; tho' it is then performed by a ſort of Inſtinct, and without our Will or Attention.

THUS it frequently happens, that they, who are ſubject to Rheumatiſms, have their Pains determined to the Intercoſtal Muſcles, and fixed there, ſo as to give acute Pain, and occaſion a great Difficulty, in Breathing. In this Caſe, the Action of Reſpiration is remarkably and laboriouſly carried on by the Diaphragm and Abdominal Muſcles only.

IN the ſame Manner, when the free Motion of the Diaphragm into and out of the Cavity is prevented by a Diſeaſe either in itſelf, in any of the Contents of the Abdomen, or in the Abdominal Muſcles; Nature moſt carefully relieves thoſe Parts from a Motion, which muſt be attended with great Uneaſineſs by performing the whole Work of enlarging and contracting the Cavity by the Motion of the Ribs only; for which purpoſe ſhe calls to her Aſſiſtance almoſt all the Muſcles, which are affixed to them, tho' many of them are principally deſign'd for other Uſes.

TWO Caſes, of this kind, I ſaw myſelf in St. *George*'s Hoſpital; which were ſo remarkable, that they ſeem worth relating.

THE Firſt was that of a Workman who fell from the Timbers in the Roof of a Houſe he was building, thro' the Jice of every Floor into the Cellar, and lighting upon his Buttocks, eſcaped without breaking or diſlocating a ſingle Bone. Together with all the Symptoms of being terribly bruiſed both within and without, he had a very remarkable Difficulty in Breathing, which was laboriouſly performed by the Motion of the Ribs only. He had frequent Returns of very violent Fits of Sneezing; and being asked by his Phyſician, whether he could fetch a deep Sigh, and ordered to try; he anſwered, No; he wiſhed he could; he wanted to ſigh; if he could but ſigh, he was ſure he ſhould find Eaſe.

BESIDES Bleeding, which gave him little or no immediate Eaſe in Breathing, and proper Care taken of him in other Reſpects, his Abdomen was ordered to be ſwathed up tight. Soon after this was done, he fetched ſeveral deep Sighs, which gave him great Eaſe; and within leſs than four and twenty Hours, the great Difficulty of Breathing was removed, and he ſoon recovered.

IT ſeems in this Caſe, as if the Teguments of the Abdomen, together with the Abdominal Muſcles, were by the Fall from ſo great a Height directly upon the Buttocks, ſtretched beyond their Tone by the Weight of their Contents, and had not Power afterwards to promote the Action of Reſpiration by ſqueezing their Contents up againſt the Diaphragm. But when the Weight of their Contents was ſupported by the Swathing up of the Belly, they ſoon recovered their Action, and gave their uſual Aſſiſtance in Sighing and Reſpiration.

THE other Caſe was that of a Girl about three Years of Age, who had a ſmall Swelling on the Back, ſituated on the lower ſmall Ribs on the Right Side, about the Bigneſs of a Walnut. The Swelling was ſoft, and plainly contained Matter, which, upon ſqueezing, receded into the Cavity; the Right Side of the Thorax was remarkably ſwelled and puffed up, inſomuch, that notwithſtanding the Child was every where elſe emaciated to the laſt degree, neither the Ribs themſelves, nor any Motion of them in Reſpiration could be perceived on that Side; but on the Left Side, they were as viſible as they are in all emaciated Subjects, and the whole Action of Reſpiration was performed by the Intercoſtal Muſcles of this Side only, excepting ſome ſmall Aſſiſtance they received from the Abdominal Muſcles, which had ſqueezed the Contents of the Abdomen from the Right Side, where they muſt have preſſed too much againſt the loaded Part of the Diaphragm, to the Left, ſo as to bunch out there in an unnatural Manner. Upon opening this Tumour there came out a very ſurpriſing Quantity of Matter, the diſcharge of which affected the Child's Breathing ſo much, and occaſioned ſuch an Alteration in the Manner of performing it, that the Surgeon was forced ſeveral Times to ſtop the Orifice with his Finger to give her Time to recover her Breath: And it was very curious to obſerve, as the Matter was thus gradually diſcharged, how the Right Side gradually reſumed its ſhare in the Action of Reſpiration, till after it was all out, both the Right and the Left Side very viſibly contracted, and dilated together, nearly with equal Degrees of Motion.

THESE Inſtances are ſufficient to ſhew us how induſtriouſly Nature provides for the Eaſe of any Parts that are diſordered, by encreaſing the Action of thoſe that are well; the Knowledge of which may be of great Service to us, as Phyſicians.

FOR the encreaſed Action of the Parts, which are not diſordered, deſigned thus by Nature for the Relief of thoſe that are, does at the ſame Time ſerve for a Direction to the Phyſician, and points out to him the particular Parts in which the Diſorder is ſeated.

THUS when we ſee either the Breaſt, or the Abdomen, laboriouſly performing the Action of Reſpiration by it ſelf, without the Aſſiſtance of the Other; we may conclude that the other is either diſordered itſelf, or prevented from performing its Share of the Action by the Diſorder of ſome other Part, which muſt neceſſarily be put in Motion by it.

AND when they both of them act equally laboriouſly, we may conclude that the Seat of the Diſorder is in neither of them, but lies deep within, and moſt probably in the Lungs themſelves.

IN THE NEXT PLACE, let us take a general View of the neighbouring Parts, which will upon any Diſorder in them more particularly interfere with the Action of Reſpiration.

THE inner Surfaces of the Ribs, and Intercoſtal Muſcles and Diaphragm, and the whole External Surfaces of the Lungs and Pericardium, are moſt exactly covered by the Pleura; which is a ſmooth ſtrong Membrane ſtretched over, and lining the whole Cavity of the Breaſt, and forming by its Duplicatures the Mediaſtinum, which divides the Cavity into Two.

THIS Membrane, when it is in perfect Health, is pliable in every Part of it, that it may conform itſelf to the perpetual Motion of all the Parts it covers; but as it is furniſhed plentifully with Arteries, Veins, and Nerves, it muſt be liable, like other Parts of the Body, to Obſtructions, Inflammations, Pain, and Suppuration; and, therefore, whenever it is in any Part of it afflicted with any of theſe Diſorders, it muſt neceſſarily very remarkably diſturb the Actions of the Parts it is ſtretched over; and, according as the Part affected is applied to the Ribs or Diaphragm, the Latter or the Former will be obliged to perform the greater Share in the Action of Reſpiration.

THE Diaphragm is lined on the other Side with the Peritoneum, as exactly as on this with the Pleura, and immediately below it lie the Liver and Stomach.

ANY Obſtruction, Inflammation, Pain, *&c.* in the Peritoneum, will as greatly interfere with the Action of the Diaphragm, as they would if they were ſeated on the other Side of it in the Pleura itſelf. The ſame Diſorders in the Liver, or Stomach, or Spleen, or indeed in any other of the Contents of the Abdomen, will proportionably affect Reſpiration, as they give greater or leſs Uneaſineſs and Pain, when they are ſqueezed up and down by the Diaphragm and Abdominal Muſcles in the Action of Reſpiration.

BUT as the external Coat of the Liver is continually applied to that Part of the Peritoneum which lines the lower Surface of the Diaphragm, there frequently happens an actual Adhæſion of one to the other, which is in reality a Diſeaſe; and tho' it makes little or no Alteration in Reſpiration when theſe Parts are both of them otherwiſe in Health, yet in an Inflammation of the Liver, which we have moſt Reaſon to believe has its Seat in this external Membrane, it greatly affects Reſpiration, and brings on ſuch Pain, and ſo many of the ſame Symptoms which attend a Pleuriſy, that an unſkilful or unattentive Practitioner may very eaſily be deceived.

IT is eaſy to ſee likewiſe, that the Quantity of Water contained in the Abdomen in an Aſcites muſt greatly interfere with the Action of Reſpiration; and the more ſo, the more the Quantity of it encreaſes. For whilſt that Quantity is ſmall, the only Inconvenience it is of to Reſpiration is owing to its Weight, and the Abdominal Muſcles muſt therefore act with greater Force.

But when the quantity of Water is ſo great, as to diſtend the Teguments of the Abdomen to their greateſt Extent, and brace them tight, the Diaphragm muſt of Conſequence be as forcibly ſqueezed up into the Cavity of the Thorax, as the Teguments of the Adbomen are ſqueezed outwards; and neither of them will have the power of moving at all: Whence it will follow, that the Muſcles, inſerted into the Ribs, muſt perform the whole Action of Reſpiration by themſelves.

THUS have we ſeen how the neighbouring Parts, when they are diſordered, may interfere with, and diſturb, the Action of the Muſcles which enlarge and contract the Cavity of the Breaſt; and the Alterations in the External Appearances in Reſpiration, which are the Conſequences of thoſe Diſorders.

AND in general we find that, when the Muſcles, which raiſe and depreſs the Ribs, or thoſe which ſwell and contract the Abdomen, are any ways ſeparately diſordered, or prevented from acting freely, Reſpiration is laboriouſly carried on by the other Set only.

THIRDLY, when the Lungs themſelves do not dilate and contract with eaſe and freedom, the Muſcles which raiſe and depreſs the Ribs, and thoſe which ſwell and contract the Abdomen, muſt both of them act laboriouſly, and with more force than they naturally do.

IN order to ſee this clearly, let us ſuppoſe the Lungs to be ſo rigid, as neither to dilate nor contract, but with the greateſt difficulty.

ON this ſuppoſition, before the Lungs will begin to dilate, and take in Air thro' the Mouth and Noſtrils, the Air in the Cavity muſt be dilated, till it becomes as much rarer than the common Air in the Lungs, as is required to give that Air a ſufficient Superiority of Force to overcome the Reſiſtance they make againſt Dilatation; and in order to expand the Air in the Cavity to this degree, the Cavity of the Thorax muſt be proportionably enlarged. And as this muſt be done before the Lungs begin to dilate, the Muſcles which raiſe the Ribs muſt at the ſame Time ſupport and overcome a conſiderable Part of the Preſſure of the Atmoſphere, upon the external Surface of the Thorax, as the Diaphragm muſt that, upon the external Surface of the Abdomen: and conſequently, the Cheſt muſt in this Caſe be more dilated, and with greater ſtreſs to the Muſcles, than it naturally is.

For the ſame Reaſon, in Expiration, the Air in the Cavity muſt be compreſſed to ſuch a Degree above the common Air within the Lungs, that it may by its Superiority of Force overcome the Reſiſtance they make againſt contracting; and conſequently, as remarkable and laborious an Action of the Muſcles will be required to diminiſh the Cavity in Expiration, as was required to enlarge it in Inſpiration.

There are ſome Particularities too, worth mentioning, which will attend theſe laborious Actions.

For in Inſpiration, the Cheſt being obliged to be remarkably enlarged, and the Air in the Cavity to be conſiderably rarer than the external Air; it will follow, that the fleſhy Portions between the Ribs, and about the Collar Bones, being preſſed much more without than they are within, muſt be ſqueezed and dented inwards; and this will be the more viſible, the more difficultly the Lungs dilate, and the more emaciated the Perſon is who breaths.

When Inſpiration once is made, the Muſcles which dilate the Cheſt ceaſe to act, and their Antagoniſts immediately begin. The Inſtant the firſt of theſe ceaſe to act, the ſuperior preſſure of the external Air upon the Surfaces of the Cheſt and Abdomen has nothing to counteract it; and conſequently, the Cavity of the Cheſt muſt that Inſtant be ſuddenly contracted, both on account of the Weight of that external Air, and of the Action of the other Set of Muſcles, till the Air about the rigid Lungs is condenſed to the ſame degree with the external Air. Conſequently, between the Inſtant at which the Cheſt is moſt dilated for Inſpiration, and the Inſtant at which the Air begins to be expired, there will be a very ſhort interval of Time, in which the Cavity of the Breaſt will be contracted with a Jirk, as if it was convulſed, without any Air's being expired; an Action we cannot imitate in Health, without forcing the Air out of the Mouth or Noſtrils.

IT might perhaps be expected, that the fleſhy Portions between the Ribs, ought to be as much forced outwards by the ſuperior Force of the internal Air in Expiration, as they are dented inwards in Inſpiration; but this cannot happen ſufficiently to be obſerved, on account of the Manner in which the Pleura is connected to the Ribs: A particular Explanation of which may be ſeen in the Appendix to theſe Lectures.

ON the ſame Account, it ſeems reaſonable to believe that between Expiration and Inſpiration, there would on this Suppoſition be juſt ſuch a Jirk, as was deſcribed before, but in a contrary Direction.

WHOEVER is curious enough to ſatisfy himſelf thoroughly of the Truth of what is here deſcribed, may ſee moſt of theſe external Appearances very evidently, particularly thoſe firſt mentioned, in the Breaſt of one in the Fit of a Convulſive Aſthma, accompanied with great Pain and Uneaſineſs. I ſay, moſt of theſe Appearances, becauſe I have here ſuppoſed the Lungs equally prevented both from Contracting and Dilating; whereas it may happen that a Diſeaſe which prevents their Dilating, may make them Contract more readily, than they would otherwiſe do; and in this Caſe, thoſe external Appearances only will occur, which depend upon their difficulty of Dilating; & *vice verſâ.*

IS it not reaſonable therefore to conclude, that the Nerves are in that Aſthma ſo affected as not to lend their Aſſiſtance in Dilating the Lungs? and conſequently, that there are ſome Muſcular Fibres in the Lungs, which in a healthy State aſſiſt and humour the Action of the other Parts, ſo as to make them more ready to dilate and contract, than they would be without them?

SINCE theſe are the Symptoms, which neceſſarily follow upon any great difficulty the Lungs have of Dilating and Contracting; they muſt always appear in a greater or a leſs Degree, whatever diſorder occaſions that Difficulty, and according as the Difficulty is greater or leſs: And conſequently, from theſe Symptoms we can only conclude that there is ſuch a Difficulty in a greater or a leſs Degree, but not from what particular Diſorder it ariſes. For this we muſt have recourſe to other Symptoms, which may accompany theſe: but there are ſuch a Variety of them, and their Combinations are ſo numerous, that there are hardly two Caſes ever met with exactly alike: It would therefore be endleſs to endeavour to particulariſe them all with accuracy. It will be ſufficient to reduce them to certain Claſſes, and even this will lead us to a conſiderable Length.

THE LUNGS may be prevented from dilating and contracting with perfect eaſe and freedom, both externally and internally. They may be prevented externally, Firſt, by adhæring to the Pleura; and Secondly, by a quantity of extravaſated Fluid taking up a Part of the Cavity, and not allowing them room to play.

FIRST, As to the Adhæſion of the Lungs to the Pleura. This is ſo common a Caſe, that I believe the Number of thoſe, who upon Diſſection are found with Adhæſions, greatly ſurpaſſes the Number of thoſe without them; but then theſe Adhæſions are of ſmall extent, except in very diſeaſed Bodies.

WHILST the Adhæſion is thus of a ſmall Extent, and the Body is in a tolerable degree of Health, the Lungs are able to play with ſufficient Freedom; and Reſpiration is but little diſturbed by it. But when it has ſpread itſelf to a great Extent, and the Lungs and Pleura are inflamed, it not only greatly interferes with the Action of Reſpiration, but encreaſes the Diſtemper itſelf.

IN this Caſe, the moſt certain Symptom to determine us that there is ſuch an Adhæſion, is the Patient's being able to lie on one Side only without Pain, and with tolerable Eaſe in Breathing; and the Adhæſion is always on the Side, on which the Patient lies with Eaſe.

FOR, firſt, when the Patient lies on the oppoſite Side, the Weight of the whole Lobe that adheres, acts in a Direction to tear it away from the Pleura; whereas, when he lies on the ſame Side with the Adhæſion, there is no ſuch Endeavour towards Separation.

AND, ſecondly, when there is an Adhæſion, and the Parts are inflamed; the Action of Reſpiration ſhould, for the Eaſe of theſe Parts, be carried on by a freer Motion of the Ribs on the other Side; but when the Patient lies on that other Side, his Poſture not only prevents that Side from relieving the other, by preventing the free Motion of the Ribs he lies on, but even obliges the diſeaſed Side to perform the greateſt Part of the Action of Reſpiration: which muſt neceſſarily rather encreaſe than alleviate the Pain and Uneaſineſs in Breathing.

SOMETIMES there are Adhæſions on both ſides the Breaſt, which for the ſame Reaſons give little or no trouble in Reſpiration, before ſome other Diſeaſe of the Lungs or Pleura ariſes; and when this Diſeaſe produces an Inflammation or Impoſtumation, one Side is generally ſpeaking more affected, than the other; and conſequently, very nearly the ſame Symptoms will appear, as when the Adhæſion was on one Side only.

IN Lungs which have been diſeaſed for a long Time, the Adhæſion gradually ſpreads, and ſometimes becomes univerſal. This is a Caſe I have myſelf ſeen more than once, and requires our Attention.

For to allow the Poſſibility of an Univerſal Adhæſion of the external Surfaces of the Lungs, on both Sides the Mediaſtinum, to the Parts which are immediately next them, amounts nearly to the ſame Thing as to allow that Reſpiration may be carried on, and Life ſupported, tho' there be no Air in the Cavity of the Thorax; and ſeems to be giving up the Neceſſity there is for the Exiſtence of Air there, and the Uſes of it; which have been ſo much inſiſted upon in theſe Lectures.

Notwithstanding this, I make no doubt but the Experiments of Dr. *Hales's*, mentioned in the Firſt of theſe Lectures, together with the Laſt of Dr. *Houſton's*, which I ſhall conſider in the Appendix; muſt convince any impartial Reader, that there always is a Quantity of Air contained in the Cavity of the Breaſt of every one, who breaths freely and eaſily, without being ſoon out of Breath upon uſing moderate Exerciſe.

Upon the Strength of theſe Experiments, therefore, let us take it for granted, that there is Air originally in the Cavity, and and ſee what the Conſequences will be of too great or too little a Quantity of it, or none at all.

It is difficult to determine, whether the Air is in the Cavity, from the very firſt Formation of it, or whether it paſſes thro' the Lungs upon our firſt endeavouring to breath; as we may ſee from an Experiment of Dr. *Hales's* it will very eaſily do. However this be, if there ſhould ever be ſo little Air in the Cavity, as to be much rarer than the common Air at the end of Inſpiration, when the Lungs are diſtended every where as much as they are accuſtomed to be; we ſee by that Experiment, that the Air will force its way thro' the Lungs, and ſupply that deficiency. But for the ſame Reaſon, no more Air will ever paſs thro' them, than what is juſt ſufficient to make the Air in the Cavity very nearly of an equal Denſity with the Air in the Lungs, when they are as much dilated, as they uſually are in Inſpiration.

HENCE it appears, that whilſt the Lungs are in Health, there is no danger of there ever being too ſmall a Quantity of Air in the Cavity, becauſe the external Air will force itſelf into it, and ſupply the Deficiency almoſt as ſoon as it happens: Neither is there a Poſſibility of too great a Quantity of it ever inſinuating itſelf this way into it; becauſe, whenever the Air within the Cavity is at the End of a forcible Inſpiration, nearly of the ſame Degree of Denſity with that within the Lungs, the difference of Preſſure will not be able to force any more Air thro' them.

BUT is there not another Source, whence we may derive the Encreaſe and Diminution of the Quantity of the Air in the Cavity? Is there not always oozing into this, as well as every other Cavity of the Body, from the exhaling Veſſels of all the Parts that form it, or are contained in it, a warm fine perſpirable Matter? and is not this Fluid as conſtantly imbibed and carried away again by the abſorbing Veſſels of the ſame Parts? May not this Fluid, like all other Vapours, ſometimes generate Air, and ſometimes abſorb it? and conſequently, ſometimes encreaſe, and ſometimes diminiſh, the quantity of Air in that Cavity?

WITH regard to the Encreaſe of Air; if too great a quantity of it be generated of a ſudden, will not the Conſequence be, preventing the Lungs from dilating ſufficiently for the Blood to circulate freely thro' them, without a laborious Dilatation of the Breaſt in Inſpiration? And muſt not this Symptom immediately ceaſe upon this Air's being abſorbed and taken up again by that Fluid? May not this be the Cauſe of ſome of thoſe ſudden difficulties in Breathing, to which Hyſterical and Hypochondriacal People are liable, who abound with all manner of of Flatulencies? This ſeems to be impoſſible for us ever to determine with any certainty.

But with regard to the Deficiency of Air in the Cavity; it is certain in general, that the Conſequence of an abſolute Vacuum there is, that every Part contained in the Thorax muſt at leaſt be cloſely applied to, and preſſed by, the whole Weight of the Atmoſphere againſt the Parts which ſurround them; and conſequently, the leſs the quantity of Air the more extended will the Application be of Part to Part; the more will the Lungs be dilated, even in Expiration; and the more will the Diaphragm be preſſed up into the Cavity, even in Inſpiration. Now a cloſe Application of one Part to another, is the firſt Step towards their Adhæring, provided they did not adhære in the firſt Formation. The Want therefore of a due Quantity of Air in proportion to the Magnitude of the Cavity, and the Size of the Lungs, muſt neceſſarily bring on at firſt an Application of ſome one Part to another; which in Time, or upon the Lungs or Pleura growing diſeaſed, will lead the way to an actual Adhæſion: And ſince the Lungs when they are much diſeaſed, are too much ſtuffed up to allow a Paſſage for the external Air to get into the Cavity and ſupply the Deficiency; and ſince the remaining Air may be abſorbed by the Vapour in the Cavity: the Quantity of Air there may on theſe Accounts be continually diminiſhing, and conſequently the Adhæſion continually ſpreading, till at laſt it becomes univerſal.

Thus do we ſee, that the natural Conſequence of ſuppoſing the Air to decreaſe gradually, till at laſt there remains none at all in the Cavity, will be firſt a partial, and afterwards an univerſal Application, and at laſt an univerſal Adhæſion of the Surface of the Lungs to every Part about them; which no one I believe ever ſaw upon opening a Patient of his own, without accounting from it for all the bad Symptoms, which had attended his Breathing at leaſt, if not for his Death itſelf.

SINCE then the Abſence of Air muſt evidently bring on ſo remarkable a Diſorder in the Organs of Reſpiration, would it be unreaſonable to aſſert that there is always Air in the Cavity of thoſe who breath with perfect eaſe, even tho' we had no Experiments to confirm us in that opinion; and to allot it this Office, amongſt others, of keeping the Contents of the Thorax from being continually applied together, and ſo preventing the firſt Cauſe of their adhæring? But when every Experiment, that has been made, ſeems to favour this Opinion, we can no longer heſitate about it; tho' we know no other Way of accounting for the Time a Perſon lives, whoſe Lungs adhære univerſally, than by obſerving that a very ſmall Dilatation and Contraction of the Lungs will be ſufficient barely to ſupport Life.

BUT there is a Diſeaſe of the ſame Sort, which when it happens at the ſame Time, with an univerſal Adhæſion of the Lungs to the Parts about them, muſt greatly encreaſe the Symptoms of it; and this is an Adhæſion of the Pericardium to the Heart: in which caſe the Motion of the Heart muſt be interfered with, as well as that of the Lungs.

I ſhall now lay before you an Inſtance of each of theſe Caſes, and an Account of the Symptoms, which attended them.

—— *Hughes* was taken into the Infirmary in *June* 1739. The only Complaint he made, was of a moſt intolerable Pain, as he expreſſed it, in the Pit of his Stomach, which tormented him without ceaſing, and had done ſo for a conſiderable Time. He was Feveriſh, his Face looked fluſhed, and he ſeemed worn down with Pain. His Pulſe was quick and low, but regular. He had a little Cough without expectorating any thing.

THIS Pain continued upon him near a Month, notwithſtanding all the Methods we could contrive to give him Eaſe, yielding only for a Time, when he was ſuffered to take large doſes of Laudanum; and ſeemed at laſt to go off of itſelf, rather than by any Medicine ordered him at that particular Time. Soon after this, his Cough encreaſed with large Expectoration, he fell into Looſeneſſes and cold Sweats, his Strength and Fleſh decayed, and he was forced to keep his Bed. In this Way he lived, ſpitting continually a large quantity of Matter, with alternate returns of colliquative Sweats and Looſeneſs, till in *September* he died. He had no great Pain, nor any very conſiderable difficulty in breathing, more than others have, who have large Impoſtumations in the Lungs.

UPON opening his Body, we found a total Adhæſion of the Lungs, to every part about them, on both ſides; the Pericardium remarkably larger than is uſual, with a great quantity of Fluid in it; and the Lobe on the Left Side ulcerated and full of Matter.

J. M. Coachman, who had almoſt from his Infancy been accuſtomed to hard Labour, as well as the Drinking of Spirituous Liquors to exceſs, in the beginning of the Winter, 1734, was ſeized with a Cough, which he neglected, till it turned Conſumptive. At the Time that I was applied to for my Advice, he was reduced to the very laſt Stage of a Conſumption, and was confined to his Bed with the following Symptoms. He had a great Difficulty in Breathing, and Pain in his Sides, ſo as not to be able to lie down in his Bed; a violent Cough, which hardly ever ceaſing deprived him of his Reſt; Colliquative Sweats, and Looſeneſſes, which took him alternately; and an Expectoration, which reſembled Matter, by every trial we could make. His Pulſe was quick and low, but regular; his Noſe was ſharp, his Shoulders *vere alati*, and his Eyes had the true Conſumptive ſharpneſs.

BY Bleeding twice or thrice, to the quantity of five or ſix Ounces at a Time; by eaſing his Cough with Pectoral Drinks, with Nitre and gentle Opiates in them; and by palliating his Looſeneſs and Sweats as occaſion required; I got him ſo much reſt and ſtrength, that he was prevailed with to be ſet on Horſeback, when he could not ride without being held on his Horſe. He began with riding only once up and down the Street he lived in, but in a very little Time was able to go out by himſelf, and ride an Hour or two. This agreed with him ſo well, and he recovered ſo faſt, that he took a Reſolution, which he kept to his Death, of confining himſelf ſtrictly to a Milk-diet, and riding out every Day, let the Weather be what it would.

IN about two Months Time after riding on Horſeback, his worſt Symptoms had almoſt left him, and he had occaſion for no other Medicine, than a gentle Opiate at Night to keep what little Cough he had from breaking his Reſt, and the Elixir Vitrioli Lond. 50 or 60 Drops of which he took twice a Day, for near three Quarters of a Year, notwithſtanding his Milk-diet, without finding any Inconvenience from it.

IN this manner he lived all the Summer 1735, towards the end of which his Spitting and Sweats entirely left him, and his Body was rather bound than otherwiſe, ſo that he left off his Drops, and took nothing but the Elect. Lenitiv. occaſionally. All the Winter and Summer following he continued well, without any other Return of his bad Symptoms, but what yielded ſoon to repeated Bleedings in ſmall Quantities at a Time. He now began plainly to recover his Fleſh and Strength, and being able to ride 20 and ſometimes 30 Miles in the Day, imagined he was equally able to return to his Buſineſs. But Driving required too much muſcular Exerciſe, and he had like to have fallen off his Box for want of Breath. In the ſame Manner he was ſoon out of Breath upon walking faſt, and was thrown into a Fit of Coughing, whenever he attempted to do it. Otherwiſe he had hardly any Cough at all.

THUS did he live for near three Years from his firſt getting on Horſeback, ſtill following his Milk-diet and his Riding, till in the laſt half Year, his Fleſh began to fall away again, and

his

his Breathing became ſo difficult, that he could not bear even the Exerciſe of Riding, without being ready to drop off his Horſe. This Symptom encreaſed apace upon him, and ſoon confined him to his Houſe, where he grew ſo bad, that he could not truſt himſelf to walk the Length of the Room, without ſomebody by him to catch him in caſe he ſhould fall.

In this laſt State he lived without any colliquative Sweats or Looſeneſs, or Expectoration, which generally attend ſo great a Decay. Nothing gave him any relief, when he was in extremity, but Bleeding in an exceeding ſmall Quantity, and this only for a few Days. He tried it indeed but twice in this his laſt Confinement, becauſe tho' his Pulſe was quick and regular, it was low and thready, and he was exceſſivelyweak. He died at laſt without Pain, or any great Uneaſineſs, except on the ſlighteſt Motion, which always brought on a ſhort dry Coughing for a few Minutes, which he could hardly bear without ſinking down in his Bed.

Mr. *Middleton* opened his Body. Upon viewing it before it was opened, we both of us obſerved, that the Abdomen was ſhrunk inwards, as remarkably, as it is in the moſt forcible Expiration. Upon opening the Thorax, we found the Diaphragm remarkably ſqueezed up into the Cavity, the Lungs perfectly ſound and entire, but every where adhæring ſo ſtrongly to the Parts about them, that they could not be ſeparated without tearing. The Lobes on the Right Side adhæring every where, ſtrictly ſpeaking, to the Pleura, Mediaſtinum, and Diaphragm; and on the Left, to the Pleura, Mediaſtinum, Pericardium, and Diaphragm. But what was moſt remarkable, was that the Pericardium adhæred every where both withinſide and without; withoutſide to the Lungs and Diaphragm; and within to the Surface of the Heart, every where but juſt at the Bottom, and ſo ſtrongly, as not to be ſeparated without tearing. It ſeemed indeed to adhære to it by Fibres. At the Bottom there was a gelatinous Subſtance, which was in all probability the Remains of the Fluid, which is found in the Pericardium, ſqueezed into a Space no bigger than one's little Finger along the Tip of the Heart. This Subſtance from one ſide to the other along the extream Edge of the Tip of the Heart was of different degrees of Conſiſtency, ſo as at one end to be as ſoft as a common Jelly, and at the other quite Membranous; and in the intermediate Space, gradually tending from the Conſiſtency of a Jelly to that of a Membrane, as might be ſeen by beginning Fibres in the ſofteſt Part of it, which were thicker ſet, and more perfectly formed, as they approached the Membranous part; ſo that the whole Cavity of the Thorax was filled up by its Contents, without any ſpace left for Air.

THIS Caſe I have related at large, with the moſt material Circumſtances, becauſe the Appearances upon opening the Thorax, were as remarkable as his Recovery, and Living for more than three Years, after his being reduced to ſo low a Condition; and after ſo noble a Part, as the Lungs, was ſo much diſeaſed.

DR. *Lower* mentions a Caſe in his Treatiſe *De Corde*, in which the Pericardium was found adhæring to the Heart, whilſt the Lungs hung freely in the Cavity.

" UXOR cujuſdam civis Londinenſis, Ætat. 30 Annorum, " olim ſatis ſana, & alacris, per tres ultimos vitæ ſuæ annos mæſta " valde, & melancholica, porro et ad motum quemvis anhela, " cum pulſu parvo, & *ſemper intermittente*, de dolore inſuper " cum inſigni gravamine præcordia infeſtante continue fere " querebatur; quin et crebris lipothymiis, & a levi quovis corporis motu ſpirituum deliquiis, & extremorum infrigidationi " obnoxia demum evaſerat: in quo ſtatu a nullis medicamentis " juvata tandem, viribus ſenſim attritis, interiit. Cadavere aperto " circa viſcera inferioris ventris nulla omnino vitia apparebant; " dum vero alias partes perſcrutamur, cordis affectionem depre-

" hendimus in quam omnium malorum cauſas merito referamus.
" Thorace enim aperto, pulmones ſatis ſani fuerunt, Cordi
" tamen toti Pericardium ubique adeo arcte accreverat, ut digitis
" non niſi ægre ab illo ſeparari potuerit; porro hæc membrana
" non, uti oportuit, tenuis, & pellucida, ſed craſſa, opaca, et
" velut calloſa evaſerat: hinc cum nulla intercapedo pro libero
" cordis motu, et nulla, quâ humectaretur, aqua adfuerat, nihil
" mirum ſi de malis his omnibus continuo quereretur. Præterea
" cum Pericardio Humano Diaphragma ſemper accreſcat, ubi
" Cor ipſum quoque pericardio uniri accidit, fieri non potuit,
" quin in omni inſpiratione Cor etiam ſecum deducere, adeoque
" motum ejus tam diu ſiſtere, & ſupprimere neceſſe habuit:
" unde pulſus iſta intermiſſio *omni inſpirationi* perpetuâ vice
" tam conſtanter ſuccedebat."

I have tranſcribed this Caſe from Dr. *Lower*, becauſe of the Symptom of the intermitting Pulſe, which he makes a neceſſary Conſequence of a total Adhæſion of the Pericardium to the Heart, and which, notwithſtanding, I am certain was ſo far from being conſtant in *J. M.* or following every Inſpiration, that I do not remember ever once to have perceived it; and therefore it cannot be the neceſſary Conſequence of ſuch an Adhæſion.

As to the two Caſes I have related; does it not ſeem reaſonable to believe that the healthy State of the Pericardium in the one, and the diſeaſed State of it in the other, were the Occaſions of the different Symptoms, which attended their Breathing, tho' in both the Lungs every where adhæred ſtrongly to the Parts about them? Is there not Air, as well as the watery Fluid, within the Pericardium? Muſt not this Air be always equally denſe with that in the Cavity, or with the Air in the Lungs? And ſince the Lungs in a healthy State, expand themſelves immediately into the Room made for them by the dilating of the Cheſt, and immediately contract when the Cheſt contracts; does the Air in the Cavity ever vary much in its degree of

Denſity, in the Actions of Reſpiration? Muſt not the Air in the Pericardium therefore continue at all times nearly of the ſame degree of Denſity likewiſe? Will not this Air therefore conſtantly keep the Pericardium very equally diſtended, and allow the Heart the ſame Space, and Liberty of Beating at all times? But further, if there is no Air in the Pericardium, there muſt either be Fluid enough in it to diſtend it equally every where about the Heart, or not. If there is, then the Heart muſt beat with the ſame Difficulty, as if the Pericardium adhæred, and its Subſtance were thickened, ſo as to take up the ſame Space, as the Water does: and if there is not Fluid enough to fill it, the Part not filled muſt by the Preſſure of the Air, or the Parts about it, be ſqueezed cloſe, and kept always applied to the Heart itſelf; which will bring it to the ſame Caſe, as if it adhæred. And conſequently, the Pericardium with its Fluid would be of little or no ſervice towards the Eaſe and Freedom with which the Heart beats. What I have here ſaid I only propoſe, as worthy of further Conſideration.

WAS it not the Largeneſs of the Pericardium, and the Quantity of Fluid there, which made *Hughes*, tho' his Lungs every where adhæred, nay tho' one Lobe was quite impoſtumated, breath with more eaſe even to his Death; and bear ordinary Motion ſo much better than *J. M.* by affording the Heart room to dilate and contract, in proportion, as more, or leſs Blood was to be circulated by it in the ſame Time? May it not be ſuppoſed that the Pericardium did not begin to adhære in *J. M.* till very near the Time of his Death; and that as that Cohæſion ſpread, he grew worſe, and leſs able to bear motion; till at laſt when it became univerſal, he could not move at all, without being in danger of the Circulation being entirely ſtopped, from the Heart's not being able to dilate but to one certain degree? and was not this at laſt the occaſion of his Death?

And from the Whole is it not reaſonable to conclude that a quantity of Air in the Cavity is neceſſary, in order to perform the Action of Reſpiration with perfect eaſe and freedom? That Reſpiration may be tolerably carried on, when the Body is otherwiſe in Health, when there is a partial Adhæſion? That Reſpiration may be ſufficiently carried on barely to ſupport Life, when the Adhæſion is total, but not ſo as to undergo any Exerciſe? That when the Pericardium adhæres to the Heart, as well as the Lungs to every Part about them; the very ſlighteſt Motion imaginable cannot be performed without danger of Suffocation? And conſequently, that the want of Air in the Cavity of the Breaſt, is one great Impediment to the Freedom with which the Lungs ought to play:

Secondly, it is eaſy to ſee that any extravaſated Fluid lying in the Cavity of the Breaſt, muſt by its weight upon the Diaphragm, as well as by taking up room there, greatly interfere with the Action of Reſpiration.

Collections of Water have been found ſometimes in one ſide only of the Cavity, ſometimes in both, and ſometimes within the Duplicatures of the Mediaſtinum. In any of theſe Places, it prevents a free Reſpiration, but moſt when it lies on both ſides.

In Dropſical People, where the Belly is much diſtended, it is very hard to determine from any difficulty or interruption in Reſpiration, whether there is Water in the Cavity of the Breaſt, or no; becauſe the Tenſion of the Abdomen, as was ſhewn above, muſt interfere with Reſpiration; and as Dropſies are moſt frequently brought on by a Courſe of hard Drinking, in which Caſe the Lungs are generally diſtempered themſelves, and adhære to the Pleura, it will on this account be ſtill more difficult. There ſeems indeed nothing to determine it by, with any certainty, but the Patient himſelf feeling ſomething move in his

Breaſt like Water, upon a ſudden change of his Poſture in Bed.

I was once preſent at the opening of a Dropſical Man, when from the Symptoms, which attended his Diſeaſe, we were all ſo certain of there being Water in one ſide of the Breaſt, that our deſign in opening him was only to ſee, whether the Water was contained in that ſide, on which he could lie with tolerable eaſe, or on the other, on which he could not bear to lie at all. On opening the Thorax, there was not a ſingle drop of Water to be found; but there was almoſt a total Adhæſion of the external Coat of the Lungs on both ſides to the Pleura, and an extended Inflammation, together with numberleſs ſmall Ulcers in one Lobe, juſt where it adhæred to the Pleura. This was enough, together with the quantity of Water in the Abdomen, to account for all the Symptoms, which related to his Breathing; and ſufficient to make us more upon our guard in our future determinations about an *Hydrops Pectoris*.

AN extravaſated Fluid of any kind whatever will diſturb the Action of Reſpiration by its weight and bulk; but when that Fluid is of a Nature to corrode, and contaminate the Parts about it, as Matter is when it begins to putrify, it will have much more pernicious Effects.

WE ARE, in the next Place, to point out the different Springs, from which the internal Diſorders of the Lungs ariſe, which prevent their dilating and contracting with that eaſe and freedom, with which they play in Health.

FIRST, the Conſtruction and Diſtribution of the Pulmonary Artreies and Veins, and the uninterrupted Circulation of the whole Maſs of Blood thro' their minuteſt Branches, have been ſo often mentioned in the Courſe of theſe Lectures, that they need not be repeated, to convince any one of how fatal a Conſequence any great Obſtruction, Inflammation, or Breach of any of theſe Veſſels, muſt neceſſarily be even to Life itſelf, or how greatly it muſt diſturb Reſpiration in particular.

SECONDLY, The Aſpera Arteria, Bronchia and Veſicles, the Coats of the Pulmonary Arteries and Veins, and in ſhort all the Subſtance of the Lungs themſelves, is in every part ſupplied with Nouriſhment by Arteries, and the ſuperabundant Fluid is carried back by Veins, which ariſe from different Springs, terminate in different Channels, and are entirely independent of the Pulmonary Arteries and Veins.

THE Lungs, therefore, are liable to Obſtructions, Inflammation, Pain and Impoſtumation, with their Train of Symptoms, from this Syſtem of Veſſels, as well as from the former; and the Pain, Uneaſineſs, and Difficulty theſe Diſorders will occaſion in the alternate Dilatation and Contraction of the Lungs will diſturb and interefere with the Action of Reſpiration.

FROM theſe Veſſels, there frequently happen Hæmorrhages, eſpecially in the Branches diſtributed about the Windpipe; which as the Blood muſt deſcend into the Lungs before it can be diſcharged, and conſequently muſt be thrown up by Coughing, will have the frightful Appearance of coming from the Pulmonary Vein or Artery; but will neither interfere with Reſpiration ſo much, nor be attended with the ſame Danger, as a Hæmorrhage from a Breach in thoſe Veſſels.

THE Blood, which is coughed up in this Caſe, is always obſerved to be more florid, than that which proceeds from a Breach within the Lungs themſelves; and the Reaſon ſeems to be this, that whilſt it trickles down the Windpipe, or Bronchia, it's Surface is as much expoſed to the Air, as when it is immediately caught in a Porringer from the Arm; which is not true in the other Caſe.

THIRDLY, Tho' the Blood does in a great Meaſure owe its nutrimental and beneficial Conſtitution, when the Body is in Health, to the Action of the Lungs; yet as there is nothing particular in their Action, different from that of the other Veſſels of the Body; it will follow, that unleſs the Chyle, which is to be mixed with the Blood, be brought to the Lungs in proper Quantities, and endued with proper Qualities; unleſs the Diſcharge thro' the Sides of the Veſicles be regularly and duly performed; unleſs a proper Quantity of Air-Particles be abſorbed, to ſupply the active Principles ſo neceſſary to the Warmth of the Blood, and the Cohæſion of its Parts; nay, unleſs the Arteries of the Body keep up and improve the advantageous Alteration of the Blood begun in the Lungs: it muſt at every return of the Circulation arrive at the Lungs; and if the ſame Circumſtances continue, paſs out of them too, leſs and leſs fit for the Purpoſes of Life. So that by degrees the Blood will be ſo much impaired and broken, that when it moſt wants the Aſſiſtance of the Lungs, it will be brought thither when it is only fit to choak up and clog the Veſicles and Capillary Arteries, ſo as to prevent the little Service it could receive in paſſing once thro' them.

THUS may the Blood itſelf, when it is once become of a broken and vitiated Conſtitution, be the Occaſion of many different Interruptions of Reſpiration,and of many Diſeaſes in the Lungs, as well Chronical as Acute, and may at laſt put a ſtop to every Action deſigned by Nature, to preſerve it of a healthy and arterial Conſtitution.

FOURTHLY, The Veſicles of the Lungs are, in a healthy State, continually diſcharging out of their Cavities what recrementitious Vapours are continually oozing from the Blood into them, and receiving in their ſtead a freſh ſupply of Air. If therefore either theſe Vapours, or thoſe in the Air itſelf, are ſuffered to lodge there, thro' any accidental diſorder or difficulty in the Action of Reſpiration, their more fluid Parts evaporate; and thoſe that remain condenſe, concrete, and perhaps corrode, at beſt clog, and render uſeleſs, the Lobule compoſed of theſe Veſicles; and it is ſeldom that theſe ill Effects ſtop, without in the ſame manner affecting a whole Lobe.

The ſame, but more fatal, will the Conſequence be of an Obſtruction, Inflammation, and ſucceeding Suppuration in the Capillary Arteries diſtributed about the Sides of theſe Veſicles; becauſe ſuch a Diſorder is not only more violent, but more likely to ſpread, and contaminate the neighbouring Lobules, till it has deſtroy'd the whole Lobe.

Nature, indeed, has been very careful to avoid the ſpreading of any ſuch Diſorders, by the many Partitions ſhe has made, and the many Diviſions of the Lungs into ſeparate Lobules, encompaſſing each with its particular Membrane: And whenever any Obſtruction is threatned in any Part, the Number of Inoſculations among the Arteries in the Lungs is moſt wonderfully contrived to carry the Blood thro' other unobſtructed Paſſages, ſo as not to encreaſe the beginning Malady; and the inner Surface of all the Air-Veſſels is thick ſet with Glands, which diſtill an oily Fluid to facilitate the Expectoration of any obſtructing Matter, that can be thrown off, by keeping thoſe Veſſels moiſt and glib.

But notwithſtanding all this induſtrious Contrivance to preſerve the Lungs; when the Solids of the Body are weak, either thro' a natural Conſtitution, Irregularity, or a long Series of other Diſtempers, the fine Contecture of the Veſicles naturally expoſes them to theſe fatal Obſtructions.

Fifthly, Theſe Glands, thus diſperſed about the Air-Veſſels of the Lungs, when they are any how diſordered, will diſturb Reſpiration, and may bring on very dangerous Diſeaſes.

WHEN the Glands ſecrete either too great or too ſmall a Quantity of their Fluid, the Veſſels that Fluid was only to keep moiſt and ſmooth, muſt either be dry for want of it, or loaded and clogged up by too much; and when thoſe Glands pour out an acrid and corroding Fluid, or grow hard and ſcirrous, as they frequently do in ſcrofulous Habits, it is eaſy to ſee what irkſome Diſorders they will neceſſarly produce in the Lungs themſelves.

SIXTHLY, The Membrane that ſeparates the Lobules from each other, is the ſame Cellular Membrane, that divides all the other minute and diſtinct Parts of the Body from each other. This is ſo certain a Fact, that the whole Body of the Lungs may be dilated by blowing Air thro' a ſmall Pipe into the Cells of this Membrane, without any of it eſcaping into the Veſicles, Bronchia, or Windpipe. As the Cellular Membrane in other Parts of the Body is known to be the Seat of one ſort of Dropſy, and to be then filled with Water; may we not conclude that this in the Lungs may be in the ſame Manner liable to a Dropſy? Will not ſuch a Condition of this Membrane prevent a ſufficient Dilatation and Contraction of the Lungs for an eaſy and free Reſpiration? Will not ſuch a Diſorder be attended with all the Symptoms of an Aſthma? Do we not, in confirmation of this, ſometimes obſerve an Aſthma go intirely off, upon the Swelling of the Legs? Does not the Aſthma return, upon that Swelling's diſappearing? Have not each of theſe happened ſeveral times to the ſame Perſon? Is not the Swelling of the Legs occaſioned by a Tranſlation of the Water, from one Part of the Cellular Membrane, which is every where about the Body, to another? Have we not known Bliſters on the Legs ſometimes relieve the Aſthma? May not we conclude from thence, that the Cauſe of the Diſorder was Water in the Membrane; and tho' the Relief is generally but for a ſmall Time, and the

Symptoms return, may not this happen from too great a flow of Watery Fluid to that Membrane, to be drained off that Way? However this be, this Membrane is certainly the Seat of Impoſtumations in the Lungs, as it is all over the Body.

SEVENTHLY, The Air it ſelf has ſo great a Share in the Action of Reſpiration, and is ſo neceſſary likewiſe to the Health and Vigour of the whole Body, that no remarkable Alteration can be made in it, without our being very ſenſibly affected by it, eſpecially when our Lungs have been weakened or diſordered before.

ELASTICITY is the Principal Quality in the Air itſelf, upon which Reſpiration depends; for without it, the different degrees of Heat could not produce that Circulation and change of Air within the Lungs, by which the perſpirable Fluid is ſo conſtantly carried off in Breathing: And for the ſame Reaſon, the Coolneſs of the external Air is likewiſe neceſſary for this purpoſe; becauſe, if that were equally warm with the Air within the Lungs, that Circulation would immediately ceaſe.

CONSEQUENTLY, when the Air we are to breath is loaded with Vapours, which render it too warm, or deſtroy its Elaſticity, or both; it becomes unfit for Reſpiration, and interferes with the Action of Breathing.

AS the Air enters into the Compoſition of all the Variety of Bodies, that we know; ſo in return it receives and ſupports, and carries along with it all the Exhalations, which can any ways fly off from Vegetable, Animal, and Foſſil Bodies. Nay, thoſe particles of Air, which have lain abſorbed within the moſt ſolid Bodies, and afterwards recover their Elaſtic State, and mix with other Air again, are not without reaſon imagined to carry along with them Particles of the Bodies to which they were before ſo cloſely connected.

IN different Seaſons of the Year, therefore, the Air muſt neceſſarily receive different degrees of Warmth from the Sun, and be filled with Vapours, both of different kinds and in different quantities.

AND according to the accidental Circumſtances of the Situation of any particular Place, will the Air about it in the ſame Manner be more clear and healthy, or more loaded with pernicious and unwholeſome Vapours.

AND as different Winds blow from the ſeveral Corners of the Earth, the Air brought by them will partake of the Nature of the Climates it paſſes thro', and be loaded with Vapours accordingly.

HENCE, we may eaſily ſee what a variety of Diſorders in breathing may ariſe from this Spring, in thoſe whoſe Lungs are weak, or have been formerly diſordered in different Manners; and how differently theſe accidental Alterations in the Air may affect the Action of Reſpiration in different People.

BUT this is not all. For as a conſiderable Quantity of the Particles of the Air is taken in and abſorbed by the Blood, and circulated with it all over the Body; the Conſtitution of the whole Maſs of Blood, and the Health of the whole Body, may be affected by the particular Conſtitutions of the Air; even tho' it has Coolneſs and Elaſticity enough not to interfere with the Action of Reſpiration.

HENCE, therefore, may proceed thoſe particular Diſorders, which are confined to certain Tracts; and thoſe, which every now and then are found to rage for a certain Time; even amongſt thoſe whoſe Lungs are ſound and healthy.

HENCE too it may be ſeen how reaſonable Dr. *Sydenham*'s Opinion is, that ſome Seaſons bring with them particular Conſtitutional Diſeaſes, to which every one is liable; which may not indeed always appear attended with the ſame Train of Symptoms, but which ought always to be regarded by every Phyſician in the Cure of almoſt every contemporary Diſeaſe: Becauſe, tho' the Air may not be loaded with Vapours of ſo noxious or peſtilential a Nature, as immediately to affect every Conſtitution alike; yet it may be ſo conſtituted as to work ſlowly upon the Blood, and diſpoſe it more or leſs, as every one's particular Conſtitution is ſtronger or weaker, towards the ſame unhealthy State. And according as any one particular Perſon has at that time made an unguarded uſe of the Non-Naturals, or as his Conſtitution is naturally more liable to one ſort of Diſtemper than another, the latent unhealthy Conſtitution of the Blood will ſhow itſelf in this or that Shape, attended with different Symptoms: which will without doubt yield more eaſily if this be attended to, than if it be overlook'd, and the Diſtemper be treated in every Seaſon exactly in the ſame Manner.

It is very certain that the ſame Diſeaſe, or rather the ſame Train of obvious Symptoms, will not admit of the ſame Method of Cure in different Climates; and that the Phyſician, who attends moſt to the Nature of the Climate, and the Diſtempers moſt frequent there, will with more eaſe get the better of any particular Diſorder, than one who is entirely unacquainted with it, or, which is the ſame Thing, who neglects taking it into conſideration. And why ſhould not the ſame hold equally true in the preſent Caſe?

This Opinion therefore of the Doctor's has undoubtedly a Foundation in Nature: and was as undoubtedly the Reſult of that careful, cloſe, and unwearied Application in obſerving all the Steps, which Nature takes, not only in throwing off, but even in producing Diſeaſes; for which he is ever to be held in eſteem by all of his Profeſſion.

Thus much for the pernicious Effects of the Air in general, as well as with regard to the Action of Reſpiration in particular.

EIGHTHLY, Beſides theſe ſorts of Diſorders, as the whole Subſtance of the Lungs, as well as the other Parts ſubſervient to Reſpiration, are ſupplied with plenty of Nerves; theſe, as well as every other part of the Body, muſt be affected by the ſtrange and ſometimes fatal Diſorders of weak and diſtempered Nerves.

AS to the Manner, in which the Nerves occaſion the Action of the Muſcles, we are abſolutely in the dark. All we know is, that without their Aſſiſtance no part whatever can perform its Office; and that when the Body is in health, and the Spirits no way affected, the Natural as well as the Voluntary Motions are duly and properly performed. But whenever the Nerves are ſo diſordered, as no longer to obey the Directions of the Will, or perform even the Natural Offices with conſtancy and regularity, the Muſcles to which they are directed, muſt of conſequence be put into Action irregularly, and produce unnatural and involuntary Convulſions; which will be more or leſs dangerous, as the Part convulſed is of more or leſs conſequence in the Animal Oeconomy.

THESE ARE THE DIFFERENT SPRINGS within the Lungs themſelves, whence the many Diſorders ariſe, to which that uſeful Organ is liable, and which are all of them in different degrees attended with an uneaſineſs and difficulty in breathing, and a laborious Action, equally perceptible on both ſides the Cheſt, and in both the Sets of Muſcles, which are concerned in enlarging and contracting the Cavity of the Breaſt.

BUT in order to diſtinguiſh theſe Diſorders one from another, which can no ways be done from the different Degrees only of this their common Symptom; we muſt have recourſe to a Variety of other Symptoms, ſome of which attend on one, and ſome on others, of them.

It will be ſufficient juſt to mention the two principal Sources, whence theſe Symptoms ariſe: One of which is the Difference in the Diſcharges made from the Lungs, when they are in health, and when diſeaſed; and the Other, the mutual Connexion between the State of the Lungs, and that of the whole Body.

First, It is eaſy to ſee that, when the Glands which are diſperſed about the Bronchia, or the Lungs themſelves, are diſeaſed; when the Lobules are ulcerated, and the Matter broke looſe into the Veſicular Cavities; when the Blood-Veſſels are broke, either in a ſmall or a large Branch; when either ſome, or all theſe happen together; the Appearance of what is expectorated, muſt vary: and the Variety muſt be ſtill encreaſed by the different Appearances the ſame Subſtance will put on, according as it lies a longer, or a ſhorter Time before it is expectorated. I have yet met with no Author, who has ſo carefully and amply deſcribed the different Diſcharges by Expectoration in the Chronical Diſeaſes of the Lungs, as Dr. *Bennet* has in his *Theatrum Tabidorum.* To him therefore I muſt refer thoſe who are curious; my Time not allowing me to be particular in their Differences at preſent.

Secondly, When we reflect on the Uſe of Reſpiration in the Animal Oeconomy, as delivered in the laſt Lecture, we cannot but ſee how ſtrict a Connexion there muſt neceſſarily be between the State of the Lungs, and that of the whole Body; ſo that one of them cannot be diſordered to any great degree, without the other's being ſenſibly affected.

I ſhall inſtance only in two Particulars.

First, As the whole Maſs of Blood muſt paſs thro' the Lungs, at every Return of the Circulation; every Fever muſt interfere with the Offices of the Lungs: becauſe in every Fever the Fluids are not only vitiated; but, vitiated as they are, they are hurried with a greater Velocity than ordinary thro' their minuteſt Veſſels. And reciprocally, any Diſorder of the Lungs, which prevents the due and uſual Dilating and Contracting of the Veſicles, upon which a free Circulation of the Blood thro' them neceſſarily depends, muſt vary the Velocity, with which the Blood moves in health; and as the other Offices of the Lungs depend likewiſe upon the ſame free and alternate Motions of their veſicular Part, the Conſtitution, as well as the Velocity of the Blood, muſt be varied likewiſe; and conſequently, the Feel of the Pulſe, as well as the Complexion of the Blood, muſt be varied by it.

SECONDLY, The Health of the whole Body does in a great Meaſure depend upon the Diſcharges being duly and regularly made in proportion to what is taken in.

THESE are made by Stool, by Urine, by Perſpiration at the Skin, and by Reſpiration at the Lungs. And whilſt the Body is in health, they are made in certain proportions by every one of theſe Ways: But when any of them are accidentally ſtopped, Nature relieves herſelf, by encreaſing the Diſcharge at one, or two, or all the others.

NOTHING will make this more evident, than the Caſe of a young Man, into whoſe Bladder no Water paſſed for twenty Days: during which time, he had frequent Sweats, ſtrongly impregnated with Urine; he had the Smell and Taſt of Urine in his Mouth and Noſtrils, which muſt certainly have ariſen from the Vapours taken up, by the Air in the Lungs, in Reſpiration; and beſides this, he had regularly every Day two, and ſometimes three, watery Stools of near a Pint a-piece, which had all the Appearance of ſheer Urine. The Fæces Alvini came away every Morning pretty ſolid; and the Urinous Stools in the Day time, moſt commonly without any mixture of the Ordure. He is now alive, and makes his Water regularly, but is ſubject to Relapſes upon taking Cold. Towards the End of the twenty Days, he was ſeized with Epileptic Fits, which he has not quite got rid of, but they are much milder than they were. In ſuch Suppreſſions of Urine, the Smell of it in the Noſtrils about the 7th, 9th, or 11th Day, is mentioned by Authors, as a fatal Symptom; and there is ſcarce an Inſtance given of any one, who ſurvived the thirteenth Day: But, as there is no one that I have met with, who takes any notice of Urinous Stools, I am apt to believe this young Man was ſaved by Nature's being able to throw off the Load into the Bowels, which had not happened in the Caſes referr'd to by thoſe Authors.

In the ſame Manner, when Perſpiration is obſtructed at the Skin, more eſpecially in a coſtive Habit of Body, that Office is more remarkably carried on by the Lungs: and when this Endeavour of Nature to throw off the perſpirable Matter of the Lungs is obſtructed, either by their being weak, or diſeaſed, or overloaded with Vapours; there ariſes a Cough, a ſtronger Effort to remove theſe Obſtructions, and the Urine is loaded with a remarkable Sediment; which are the moſt common Symptoms of what we call a Cold: which generally goes off, either with a free and large Expectoration, or a Return of Perſpiration at the Skin in kindly Sweats, or a gentle Looſeneſs. All which are agreeable to what is here laid down.

And when the Lungs are ſo diſeaſed, as not to be able to ſuffer ſo conſiderable a Diſcharge to be made there, as is required; that Office is performed for them in the Bowels, and at the Skin. And as in Conſumptive People, the Lungs continue in this State for a long Time; the Pores of the Skin, and the exhaling Veſſels in the Bowels, are by conſtant uſe and the habitual Flow of the Fluids to them, ſtretched, and enlarged beyond their healthy Sizes; and the Fluids likewiſe, for want of the Aſſiſtance of healthy Lungs, and a ſtrong Circulation, are more attenuated, leſs equally mixed and blended together, and more apt to run off in large Quantities at theſe Places, than they are in a healthy State.

HENCE it ariſes, that the encreaſed Perſpiration of theſe Parts, which at firſt relieves the whole Habit of the Body, muſt at laſt weaken, and bring it to decay; by terminating in colliquative Looſeneſſes and Sweats: And hence it is, that in theſe Diſeaſes, when one of theſe Diſcharges is ſtopped by the force of Medicine, the other breaks out ſoon after in a more violent Manner.

THESE therefore are the principal Ways, in which the Lungs and the reſt of the Body are mutually affected, ſo as in a good Conſtitution to aſſiſt each other in removing any accidental Diſorder; but in a vitiated one, to join their Forces in haſtening the Decay of the Whole.

CONSEQUENTLY, the different Feels and Velocities of the Pulſe; the different Conſiſtency and Complexion of the Blood; the different Quantities of the Diſcharges by Stool, by Urine, and by the Skin; the different Appearances of the Diſcharge by Expectoration; together with the different external Appearances in the Action of Reſpiration, deſcribed above; muſt all of them be taken into conſideration, when we undertake either the Cure, or the Theory, of the principal Diſeaſes of the Organs of Reſpiration.

FOR though, at the Beginning of this Lecture, we ſuppoſed, for the ſake of Method, and clearneſs of Conception, the Lungs, and the reſt of the Body, every way elſe in perfect Health, except in the particular Diſorders, which came by turns under Conſideration; it muſt by this time be very evident, that this can hardly happen ſo in fact. The cloſe Connexion among the minute Parts, which compoſe the Lungs, and the mutual Connexion between their Health, and that of the whole Body, make it next to impoſſible for any conſiderable Diſorder to befall any part of the Lungs, without the Whole, or indeed without the reſt of the Body, being more or leſs affected.

HENCE it is plain, that there are none of theſe Diſeaſes, ſo conſiderable as to be marked out and diſtinguiſhed by Authors under particular Names, that are not of a complicated Nature; or do not owe their Riſe to the Diſorders of ſeveral Parts of the Lungs; and beſides, are not attended with ſome Diſorders of the whole Body.

AND as we have ſeen that the Diſorders of the Organs of Reſpiration affect the Velocity and Conſtitution of the Blood, and diſturb the Equality of the Diſcharges, which muſt neceſſarily be made to keep the whole Body in a healthy State; and on the other Hand, that Fevers of almoſt all kinds muſt interfere with, and diſturb, the Offices of the Lungs, and their regular Dilatations and Contractions: it is hardly to be conceived that any ſuch conſiderable Diſorder, as we are now talking of, ſhould happen, without either producing, or being produced by, a Fever of ſome ſort or other.

For this Reaſon, the Diſeaſes of the Organs of Reſpiration are divided by Authors into Acute and Chronical, according as there is, or is not, an Acute Fever joined with them.

AND as the Violence of a Fever muſt not only encreaſe the Danger naturally attending on any Diſeaſes of theſe Parts, on account of their Make, Situation, Uſe, and conſtant Motion; but muſt likewiſe hurry on the moſt fatal Symptoms in a very ſhort Time; their acute Diſeaſes ſeem more particularly to require our matureſt Conſideration: that we may not at ſo critical a Juncture either order any thing that is improper, thro' the Hurry and Impatience, or neglect any thing that is neceſſary, thro' the Fear or Prejudice of the Patient, or his Friends about him.

TO theſe therefore I ſhall confine myſelf in the remaining part of this Lecture.

IT may perhaps be expected, after ſo long a Detail of the Make of the Lungs, and their Uſes in the Animal Oeconomy;

and ſo nice an Enumeration of the many Sorts of Diſorders to which they are liable; that ſome Rules might be eſtabliſhed, upon which to build the Methods of Cure, ſo very plain and certain, that when they were once made known, every body might equally make uſe of them with ſucceſs. But whoever will conſider what has been inſiſted on in the laſt two or three Pages, will eaſily ſee that the Fever is the firſt and moſt material Object of our Care in theſe acute Diſeaſes, as it is that which ſo immediately endangers the Life of the Patient; and conſequently, that unleſs ſome plain and certain Rule were known for the Cure of all the Variety of Fevers, none ſuch can be expected from the Theory of Reſpiration only, tho' it were ſuppoſed to be never ſo perfect.

LET us however ſee how far our Theory may be of ſervice to us, by ſuppoſing a Perſon otherwiſe in Health, and of a good Conſtitution, to be ſeized with a violent Inflammation on the external Surface of the Lungs, and that this Inflammation was left quite to itſelf. Let us likewiſe ſuppoſe, if poſſible, the reſt of the Body no otherwiſe affected, than it would have been if the Inflammation had happened on the Surface of any of the Limbs.

THIS Inflammation would, like all others, either diſſipate of itſelf, and then the Perſon would recover; or end in Suppuration. In this Caſe, the Matter thus made and collected would in time break looſe, either into the Air-Veſſels of the Lungs, or into the Cavity of the Thorax, or externally thro' the Intercoſtal Muſcles and Skin, if there was an Adhæſion of the Lungs, where they are inflamed, to that Part of the Pleura which lines the Ribs.

IN either of theſe Ways, before the Matter can be diſcharged, it grows putrid, corrodes, and contaminates the Parts about it; and the Perſon afterwards lingers out a miſerable Life, either by continually Coughing and Spitting away his Lungs piece by piece, in the firſt Caſe; or by artificial Drains in the others, which may be made by the Surgeon, till at laſt ſome conſiderable Blood-Veſſel is worn thro', and burſts, and the Effuſion of Blood ſuffocates him.

These are ſome of the fatal Conſequences we may eaſily foreſee from our Theory. And from hence we muſt conclude that we are to uſe our beſt Endeavours to prevent the Inflammation from ending in Suppuration; and that, upon the preſent Suppoſition, this Inflammation is to be treated, as nearly as we can, in the ſame Manner as any accidental one on the Arms or Legs.

As Bleeding is found to be of the greateſt Service in ſuch external Inflammations, it is very plainly pointed out to us in this; and as the Diſtance of the Part affected from any large Vein that can be opened, is ſo great, there is a Neceſſity of taking away a great deal of Blood before the whole Maſs can be ſufficiently diminiſhed, for it to receive any Relief.

And as all topical Applications are denied us, we have only cooling and ſoft Emulſions to aſſiſt our Deſign, and ſupply the Place of the Blood thus taken away; and if there happen a teaſing Cough, attended with a ſmall Expectoration ſtreaked with Blood, we may give gentle Opiates to quiet, and Linctuſes to facilitate the Expectoration.

This is in general the Method, which Reaſoning on the Make and Situation of the Parts dictates to us, and which Experience has confirmed to be the propereſt, on our preſent ſuppoſition that the Diſeaſe is only an Inflammation on ſome of the principal Parts among the Organs of Reſpiration; and that what Fever there is ariſes only from that Inflammation; and that the Conſtitution is otherwiſe perfectly good.

But as we know from Experience that, in Fevers, there frequently happens an Inflammation, or Inflammatory Eruption, upon ſome Part or other, which it is of the worſt Conſequence to repell and ſtrike in, and which often ſuppurates; ſuch an

Inflammation may fall upon the Organs of Reſpiration; in which caſe, the greateſt Danger is threatened, either from our permitting it to impoſtumate, or attempting to prevent it by ſuch frequent Repetitions of Bleeding, as we ſee are neceſſary to that End from the Situation of thoſe Parts. In the firſt Caſe, the certain Conſequence is a nauſeous Chronical Diſeaſe, which generally ends in the Death of the Patient; and in the Latter, a great Riſque is run in diſturbing and interrupting the natural Courſe of a bad Fever. In this Dilemma, we are to uſe our utmoſt Endeavours, and apply all our Thoughts, to manage in a Way between the Two; ſo as to prevent the Suppuration, without interfering more than is neceſſary with that Courſe the Fever would naturally have taken without this Impediment.

WHENEVER therefore a Phyſician finds a Patient labouring under the Heat, Thirſt, and Reſtleſſneſs of a Fever, and at the ſame Time violently afflicted with a Pain in his Side, Cough, Difficulty in Breathing, or any other of the Symptoms, which ſhow the Organs of Reſpiration are diſordered; he is diligently to enquire into the Riſe and Progreſs of the whole Diſeaſe, and carefully to examine into every Complaint, in order to form a Judgment, whether the Diſorders in his Breathing are owing to the Fever, or the Fever to them.

IF it appear evidently, that they ariſe from the Fever; his next Enquiry ought to be into the Nature and Genius of the Fever itſelf, independent of the Complaints in Breathing: becauſe tho' the Violence of the Pain, and the great Difficulty of Breathing, muſt be regarded, and alleviated, yet the Cure of the Patient muſt in the End depend upon the Cure of the Fever.

AND as it is known by Experience, that there is a great Variety in Fevers; that ſome will not abate, but rather grow worſe, on bleeding, whilſt others will hardly yield to any Method without frequent Repetitions of it; that ſome will be greatly encreaſed by a warm Regimen, which readily yield to a cooling one, whilſt others are ſo low, as to require the conſtant Uſe of the warmeſt Cordials; that ſome will not bear even the gentleſt opening Phyſick, without a very dangerous Looſeneſs following upon it, whilſt others viſibly encreaſe, unleſs the Body be kept open by the daily Uſe of Glyſters, or ſmall Doſes of Rhubarb; that ſome will give way at once, as it were to a Charm, on the Application of Bliſters, whilſt others receive no Benefit at all, but are rather encreaſed by the Pain and Fatigue they occaſion; *&c.* As, I ſay, there is ſo great a Variety in the Nature of Fevers, and the Methods of Treatment they will ſubmit to; and as theſe acute Diſeaſes of the Organs of Reſpiration often accompany and depend upon each of theſe kinds of Fevers; it is impoſſible for any one general Rule to be laid down for the Management of them: But the whole muſt depend upon the Judgment of the Phyſician, formed at the Time from the Circumſtances of every particular Patient.

I SHALL, therefore, in the next Place, endeavour to point out the Ways we have of judging in particular Caſes, which of the different Methods of treating theſe Diſorders is to be made uſe of, preferibly to the others; whether it be more adviſeable to proceed by repeated Bleedings, by the cool Method, by the hot one, or by the Application of Bliſters.

THIS I am ſenſible is a very difficult Task; and perhaps may not poſſibly be done with ſufficient Accuracy, for us ever to frame any certain Rule, by which we may judge at once of the Nature of the Fever, and the particular Method we are to purſue: but I make no Doubt that there may be ſome Signs pointed out, by which we may at leaſt be directed, when to deſiſt from too obſtinate a Purſuit of any of them.

FOR tho' it be confeſſed to be difficult for us to determine of what ſort the Fever is, which attends a Pleuriſy, (for example) ſo ſoon as the Violence of the Pain, and the Danger of the

Diſeaſe, requires us to do ſomething; yet if we know that different Fevers make it neceſſary for us to purſue different Methods, we may be as certain that they will not all be equally relieved by the firſt or ſecond Steps in the ſame Method; *viz.* they will not all be equally relieved by Bleeding: And conſequently, if Bleeding once, or a ſecond Time, affords little or no Relief; but, on the contrary, if the Pulſe falls, and the Strength and Spirits flag, whilſt the Pains in the Side and Difficulty of Breathing continue as violent as ever, or nearly ſo; we may be very certain, the Fever will not admit of this Method, and an obſtinate Repetition of Bleeding muſt be dangerous. This therefore will be a true and proper Mark for us to know, when to deſiſt.

I HAVE inſtanced particularly in Bleeding, becauſe it is univerſally allowed to be the very firſt Step that ought to be taken towards the Cure; a Step, which the Violence of the Pain, and Difficulty of Breathing, abſolutely require, in order to prevent their encreaſing the Fever to a more dangerous Degree: and becauſe the Operation itſelf affords us an Opportunity of examining into the Alterations which the Blood has undergone in the Fever; and this, together with the Feel of the Pulſe, and the Strength and Spirits of the Patient before and after Bleeding, will greatly aſſiſt us in determining whether we are to proceed in the Hot or the Cold Method.

IF the Patient be of a full Habit of Body, with ſtrong Veſſels, and the Pulſe high, and the Spirits good, both before and after Bleeding, and the Blood of a florid ſcarlet Colour, with little or no Serum; or very ſizy: Bleeding is evidently to be repeated, even to the fourth Time, if the Symptoms require it; and the cool emollient Method to be purſued: And towards the decline of the Inflammation, if the Continuance of the Pain demands it, Bliſters may be applied, and generally anſwer their Deſign.

But if the Patient is of a weak and low Habit of Body; if his Strength and Spirits flag, and his Pulſe ſinks on Bleeding; and, together with theſe Symptoms, the Pain and Difficulty of Breathing continue; we have very good reaſon to believe the Loſs of more Blood may be attended with very dangerous Conſequences, ſuch as Attacks upon the Brain, Syncopes, *&c.* and we ought to deſiſt, as was ſaid before.

In theſe Caſes the Blood is generally of one, or other of theſe very different kinds. It is either very ſizy: or has all its Parts broken, diſſolved, and blended together; and what little Craſſamentum there is, breaks upon the ſlighteſt Touch, and mixes with the reſt.

In the firſt Caſe, a free Uſe of the Volatile Salt, or Spirit of Hartſhorn, the Volatile Salt of Amber, or ſuch like, repeated every ſix, four or three, Hours, as Occaſion requires, together with warm Medicines, are of the greateſt Service, and ſometimes give almoſt immediate Relief. Bliſters too may in this Caſe be applied at the very firſt ſinking of the Pulſe and Spirits, as they anſwer the ſame Intention with the other volatile Salts. It ſeems to be from Caſes of this kind that Goats Blood, and Horſe Dung, merely as containing volatile Salts, or Spirit, have gain'd their Reputation for the Cure of Pleuriſies.

In the other Caſe, neither Bliſters, nor the volatile Salts, ſeem to afford ſo much Relief to the Patient, as large Quantities of Acids; ſuch as diſtill'd Vinegar: together with the warm cordial Medicines, as Mithridate, Confect. Raleigh, *&c.* At the ſame Time, a Whey made with the Aqua Theriacalis is a very ſuitable and beneficial Drink for conſtant Uſe.

These I only offer as Hints, that may be ſerviceable in guiding us to the right Method of Cure; by which I mean, the Method moſt agreeable to the Nature of the Fever which accompanies the Diſorders in Breathing, in theſe acute Diſeaſes:

but not with a Deſign that either of theſe Methods ſhould be obſtinately followed, when either the Pain or the Fever does not yield to us. On the contrary, they ſhould be conſtantly vary'd, as the Symptoms may require.

BUT that I may not be thought to have advanced what I have ſaid of the different Manner of treating theſe Fevers, merely on my own Authority, and as the Reſult only of my own Obſervation, I ſhall tranſcribe a few Sentences from the Works of Dr. *Sydenham*, where he takes occaſion to deliver his Opinion in general of the Manner of judging at what Times his own Method of curing Pleuriſies, by quick Repetitions of bleeding in large Quantities, ſhould not be purſued

"HANC jam nactus anſam," ſays he, "paucula de eo dicam, quod omnium ore tritiſſimum eſt, *Pleureſin* ſcilicet quandoque ita *malignam* reperiri, ut per eos annos *Phlebotomiam ferri neſciat ſaltem toties repetitam quoties hic morbus communiter depoſcit.*

"CENSEO quidem *Pleureſin Veram & Eſſentialem*, quæ ut poſthæc dicetur, omnibus annorum omnium Conſtitutionibus indifferenter infeſtat, *omnibus indifferenter annis Venæſectionem pariter repetitam indicare*; aliquando tamen accidere, ut Febris ejus anni proprie Epidemica, a repentinâ aliquâ manifeſtarum aeris qualitatum alteratione, materiam morbificam in Pleuram aut Pulmones libenter deponat, ipſaque febris nihilominus eadem prorſus maneat. In hoc caſu, etſi *Venæſectio poſſit concedi*, ut huic ſymptomati, ſi multum ſæviat, occurratur; generaliter tamen ſi loquamur, *non multo plus ſanguinis ſymptomatis ratione educendus eſt, quam febris nomine debuerat* educi, a quâ pendet iſtud ſymptoma; namque ſi hæc ejus ſit indolis ut a repetita venæſectione non abhorreat, poteſt ea repeti in Pleuritide, quæ ejuſdem ſymptoma eſt; at vero *ſi febris repetitam Venæſectionem reſpuat, ne-*

“ *que juvabit iſta, immo & nocebit in Pleuritide,* quæ cum
“ febre ſtabit cadetve.

“ Hoc modo autem ſe res habuit, me ſaltem judice, in *Pleuri-*
“ *tide Symptomaticâ*, quæ febrem comitabatur hoc in loco
“ graſſantem quo tempore ſubingrediebantur *Tuſſes*, hac nimi-
“ rum hieme 1675; atque hoc quidem mihi ideo reticendum non
“ erat, quod exiſtimem dubio illum tramite errare, atque incerto
“ duci filo, qui in febrium curatione non continenter ob oculos
“ habet anni *conſtitutionem quatenus huic aut alteri morbo*
“ *Epidemico producendo favet, cæteriſque morbis omnibus*
“ *una concurrentibus in ejus ſimilitudinem ac normam detor-*
“ *quentes.*”

THERE is a remarkable Paſſage to this Purpoſe in Dr. *Tabor's Exercitationes Medicæ*, which I ſhall tranſcribe likewiſe, and then conclude.

“ HISCE præterea rebus fidem faciat Febris cujuſdam in-
“ doles, a nuperis annis, inter harum Regionum Plebeios,
“ admodum funeſta; quæ nunc hâc, nunc illâ Anni tempeſtate
“ oppulariter graſſari ſolita eſt. E genere erat Pleuritico;
“ Horroribus & Rigoribus exordiebatur ingentibus; qui quo
“ diutius erant protracti, eo infæliciorem Ægrotationis præ-
“ nuntiabant exitum: hiſce autem remittentibus, e veſtigio ex-
“ cipiebant dextri Lateris dolor acerbus, & haud raro ſpaſma-
“ ticus, Virium proſtratio inſignis, ſpirituſque difficilis: in Præ-
“ cordiis porro pondus grave, cruciatuſque obtuſus ſentiebatur.
“ Ut plurimum nec acris erat Calor, nec Pulſus celer aut
“ durus, nec Tuſſis crebra, nec Sitis ingens, nec liquata nec
“ aſtricta erat Alvus. Urinæ Craſſæ ſedimentum non depo-
“ nentes, colorem habebant ſtramineum. Vigiliæ pertinaces
“ totum fere morbi curſum comitabantur: Mente tamen con-
“ ſtabant Ægroti. Primo quidem ſicca erat Tuſſis; exactis
“ autem præter propter 24 horis, Pituita tenuis non raro, &
“ cruenta expuebatur: poſtea vero Pituita tum quantitate cum
duritie

“ duritie auctâ, frequentiores erant, & diuturniores tuſſiendi
“ conatus; uſque dum vel a ſputo admodum copioſo ſolveretur
“ Morbus, vel a Phlegmate glutinoſo intra Pulmones reſtante
“ ſtrangularetur Æger: quod quidem plerumque ante Diem
“ nonum accidebat; raro ſerius, ſæpe ocyus; *idque præcipue*
“ *ſi ſanguinis detractio intempeſtive fuiſſet repetita.* Præter
“ robuſtos, & plethoricos Juvenes, haud quenquam ſanguinis
“ jacturam ſine incommodo pati obſervatum eſt: ex iis
“ quidem bis, nonnumquam ter, primis Morbi diebus, ſanguinem
“ educi utile erat; ex aliis autem vel non omnino, vel
“ paucis tantum horis ab acceſſione inſtituenda eſſet Phlebotomia;
“ quæ etiam exigua ſummo foret periculo, niſi cito datum
“ eſſet Medicamentum proritans Vomitum eique validiſſimorum
“ Expectorantium uſus ſuccederet aſſiduus. Ea enim erat
“ Morbi conditio, ad totum Curationis opus a Phlegmate
“ viſcido copioſe expectorato abſolveretur quod (niſi in Plethoricis)
“ facilius feliciuſque, a Sanguine non miſſo quam ab
“ ejus diſpendio, procederet. Sanguine enim e non Plethoricis
“ educto, Expuitionem ſupprimi difficilemque admodum &
“ ſtrepitantem Reſpirationem exoriri, ſolenne erat: *quo* etiam
“ *ſæpius* ſecabatur Vena, *eo magis omnia ſymptomata intendi,*
“ *eo citius mortem accelerari*, obſervatum eſt.”

THERE is no doubt, but thoſe Phyſicians, who have a large Share of Buſineſs, and Numbers in Fevers continually under their Care, acquire a Sagacity, which is not to be taught to others; by which they can more readily and eaſily judge of the Nature of the Fever, and conſequently of the proper Method of Cure, than they who have not the ſame Opportunity. But this is no Reaſon why others ſhould not be upon their guard; and endeavour to form to themſelves Rules, and Hints for Obſervation, as well to acquire that Sagacity in Time, as to avoid the moſt dangerous Conſequences of the Want of it at preſent.

AND tho' theſe Hints, that I have offered, may appear too general, they are not however to be totally neglected, or deſpiſed; becauſe they are equally ſerviceable in the Treatment and Obſervation of all Fevers in general, as well as thoſe in particular which are attended with Diſorders in the Organs of Reſpiration; and becauſe they are every where left to the Judgment of the Phyſician to follow, as the different Combinations of the Symptoms appear moſt to require.

INDEED the whole Deſign of mentioning them at all was only to prevent too prevailing a Cuſtom, of treating the ſame Train of obvious Symptoms always in the ſame Manner, without conſidering to how many different Cauſes they may be owing: A Cuſtom, which owes its Riſe to general Names having been given not only to thoſe obvious Symptoms, as if they attended only on one Diſeaſe, but to the favourite Medicines too of ſome Phyſician in Repute for that Diſeaſe; whence thoſe who are learned only in Receipts, are too apt to preſcribe to the Name of the Diſeaſe, and not to the Diſeaſe itſelf: And the very Opinion, which a Beginner in the Practice of Phyſick may have formed of the Skill of the Phyſician he borrows his Receipt from, may lead him into a Method of Cure, which that Phyſician himſelf would not have purſued at that particular Time.

APPENDIX.

SINCE theſe Lectures were publickly read at the *College of Phyſicians*, I have carefully peruſed and conſidered the Experiments publiſhed in the *Philoſophical Tranſactions*, N° 441. for the Months *April*, *May* and *June*, 1736, which I had not met with before.

THEY were made by Dr. *Houſton* at *Leyden*, in the Years 1728 and 1729, and communicated to the Royal Society after the Doctor's Death, by Mr. *Miller*, under the Title of *Experimenta de Perforatione Thoracis, ejuſque in Reſpiratione effectibus*.

THE two laſt of theſe Experiments were made ſo nearly in the ſame manner with Dr. *Hales*'s, and the Second of our Experiments, mentioned in the Firſt of theſe Lectures; that I was very much ſurpriſed, at firſt reading them, to find ſo great a Difference in their Events; and began to ſuſpect, that one or other of us had not been ſufficiently accurate in our Obſervations whilſt the Experiments were making.

BUT when I had more attentively weighed all the Circumſtances of each Experiment, I found that all the different Appearances, notwithſtanding they ſeem ſo contradictory to one another, were the natural Conſequences of the Action of Reſpiration, as it is accounted for above, and are ſo many farther Confirmations of the Truth of what is there delivered.

I MUST, therefore, beg the Reader's Patience, whilſt I tranſcribe the Doctor's Account of theſe Experiments, and endeavour to explain the Reaſon of the curious Phænomena which were the Conſequences of them.

EXPERIMENTUM V.

"25 Jan. 1729. Cani mediocri, aſſeri alligato, Thorax apertus
" fuit utrinque, largo vulnere. Animali vox non defecit, &
" pulmones adeo non collapſi ſunt, ut per Aperturas eruperit
" utrinque illorum lobulus. Lobuli hi extus hærentes dilatari,
" & contrahi non deſierunt; et quod maxime mirum, *dilatatio*
" illorum Thoracis *contractioni* erat *ſynchrona* & *contra*. Aer
" in pectoris cava inflatus animalis reſpirationi nihil nocuit."

" POSTQUAM ſic per ſemihoram vixiſſet, ſine ulla vocis,
" vel reſpirationis læſione ſenſibili; Thorax ab uno latere aper-
" tus fuit ulterius, diſciſsâ coſsâ. Tumque apparebat (magnum
" paradoxum) pulmonem *contrahi*, dum pectus *dilatabatur*, *di-
" latari* dum hoc *anguſtabatur*."

" HUIC etiam operationi ſupervixit canis, donec re ab omni-
" bus abunde perſpectâ, laqueo ſtrangulari damnatus eſt."

IT were to be wiſhed the Doctor had been a little more accurate in giving us an Account of the Sizes of the Wounds, and between what Ribs they were made; but as he has not, we muſt endeavour to gueſs as well as we can.

FIRST, then, it is pretty evident, the firſt Wounds that were made were only longitudinal ones, between two Ribs; becauſe the Doctor ſays, that one of theſe Wounds was afterwards enlarged, by cutting away Part of one of the Ribs: and that they were not *very* large, is reaſonably to be ſuppoſed, both becauſe the Dog lived above half an Hour without any ſenſible Alteration in his Voice, or Breathing; and becauſe the Ends of the Lobes, which were thrown out, were ſtuck and held faſt in the Wounds, ſo as to remain out even during Inſpiration.

2dly, As to their Situation; this ſeems to have been among the middle Ribs: for had they been made lower, the Lobes could hardly have reached far enough to have hung out; and had they been higher, the thicker Parts of the Lobes would have been applied to their inner Orifices, and no Part been thrown out; as it was in Dr. *Hales*'s Experiment.

THE Appearances, upon firſt opening the Thorax, were like thoſe in our firſt Experiment; in which the Ends of the Lobes were very violently thrown out at the Orifice, and remained ſo ſome time. But the Motions of the Breaſt and Lungs, in our Dog, were ſo violent and irregular, and his Death ſo ſudden, that we cannot recollect enough to determine us now to ſay poſitively, whether the Ends of the Lobes, whilſt they were out, did alternately contract and dilate or no: But I am myſelf inclinable to think they did not, becauſe, to the beſt of my Remembrance, they continued out only during the prolonged Expiration, and immediately collapſed upon Inſpiration.

HOWEVER this be; in the Doctor's Experiment, they continued out for a long time, and never ceaſed dilating and contracting; and what was very ſurpriſing, they dilated when the Thorax contracted, and contracted when the Thorax dilated.

THIS Appearance we are now to explain. In order to this, it muſt be conſidered, that thoſe Parts of the Lungs, which are within the Breaſt, are expoſed to the Preſſure of the Air within the Cavity; and thoſe Parts, which hang out at the Wounds, are expoſed to the Preſſure of the external Air; and laſtly, that all Communication is ſtopped between the Air within and that without, by the Parts of the Lobes thus forcibly thruſt out at the Wounds at their firſt being made.

WHEN the Breaſt is contracted, the Air in the Cavity, being condenſed, preſſes more forcibly on the Lungs within, than the external Air on the Ends of the Lobes without. In Expiration therefore, which is the Conſequence of this ſuperior Preſſure of the Air in the Cavity, Part of the Air in the Lungs, which otherwiſe would have paſſed out at the Wind-pipe, will now be forced into the Ends of the Lobes, which hang out at the Wounds; by which thoſe Ends muſt be dilated when the Breaſt contracts.

AND when the Breaſt is dilated, the Air in the Cavity becoming rarer, preſſes leſs forcibly on the Lungs within, than the external Air on the Ends of the Lobes without. In Reſpiration, therefore, which is the Conſequence of the ſuperior Preſſure of the external Air, the Air will be forced out of the Ends of the Lobes back into the Lungs again; by which they muſt be contracted when the Breaſt dilates.

I SHALL defer the Conſideration of the other Appearances in this Experiment, till I have explained thoſe in the Doctor's Sixth; which, as they are of the ſame Nature with theſe, only more ſimple, ought firſt to be accounted for.

EXPERIMENTUM VI.

"CANEM parvulum, extenſis artubus, firmiter ſuper aſſerem " ligavimus. Cutis elevatæ portionem forfice abſcidimus, eâ " Thoracis parte, quâ coſtæ ab incumbentibus muſculis minime " teguntur. Abſterſo ſanguine, & fluxu ejus vini ſpiritu cohibito, quicquid adhuc coſtas, & intercoſtales muſculos tegebat, " id arreptum tenaculo abſcidimus; tandemque et ipſos intercoſtales muſculos caute ſeparavimus. Membrana Pleura dicta, " hoc modo nudata, hæcce aſpicientibus exhibuit Phænomena."

"DUM pectus *dilatabatur*, apparebat intus membranæ applicatum aliquod *album*; dum vero *anguſtabatur* pectus & expirabat animal, album illud ſurſum fugiens locum ceſſit aſcendenti cuidam corpori *rubro*; tumque mox *dilatante* ſe pectore, " *rubrum iterum deſcendit*, locum ejus occupante *albo*; & *ſic* " *per vices*."

" HOC viſo, *ſuperius* coſtarum *interſtitium* etiam muſculis " nudavimus, ſed eo in loco apparuit *nihil niſi album.*

" MEMBRANA, utrâque parte, quâ nudata erat, dum pectus " *dilatabatur*, ſiebat *concava*; dum *anguſtabatur* paululum (ſed " vix ſenſibiliter) *convexa*.

" HISCE ad ſatietatem contemplatis, diſciſſis duabus coſtis " pectus aperuimus, tam amplo vulnere, ut quicquid fere in eo " latere continebatur oculis pateret."

" ANIMAL, hoc facto, vocem non amplius edidit, quamvis " ab altero latere Thorax ejus eſſet illæſus. Pulmo multum illi- " co collapſus eſt; ſed alternum dilatationis & contractionis mo- " tum non penitus amiſit: eratque omnium aſpicientium con- " ſenſu, *dilatatio* ejus *contractioni* Thoracis *ſynchrona*, & *con-* " *tra*."

" CORDIS tandem ventriculus pertuſus eſt, ut intruſus digi- " tus ſentiret vim ejus muſcularem; ſicque de Reſpiratione ſi- " mul et Vita actum eſt."

THE latter Part of this Experiment only being to our preſent Purpoſe, I ſhall confine myſelf to that. And, here it muſt be obſerved, 1. That there was at laſt a very large Opening made into the Cavity of the Thorax; Part of two Ribs being taken away, ſo that three Interſtices were laid into one, and almoſt all the Contents of the left Side of the Thorax were expoſed to view: And, 2. that the lower Edge of this Opening was ſo near the Diaphragm, as to be within the Reach of it in Expiration; for the red Body, which was applied to the Pleura, when the Breaſt contracted, was undoubtedly the Diaphragm.

WHENCE, and from what was ſaid above, it is eaſy to ſee, 1ſt, that the Ends of the Lobes could not be thrown out at the Wound, becauſe the Air in the Cavity had a free Paſſage into the open Air, as ſoon as it began to be condenſed in the lower Part of the Thorax: And, 2dly, by our firſt Experiment, that the Contraction and Dilatation of this left Side of the Thorax, could not produce any Difference in the Denſity of the Air within it, and conſequently that whatever Motion was to be ſeen in this left Lobe, was not at all owing to the dilating and contracting of the Side of the Thorax which contained it.

IF, therefore, we would enquire into the Cauſe of the alternate dilating and contracting of this left Lobe, we muſt look for it on the right ſide of the Thorax, which was in this Experiment left untouched.

NOTWITHSTANDING, therefore, what had been done on the left Side, Reſpiration went on as uſual, on the right. In Expiration, the Air in the right Lobe was condenſed, and Part of it, inſtead of going out at the Wind-pipe, forced its way into the Left, and dilated it till the Air within it came into an Equilibrium with the external Air which ſurrounded it; and in Inſpiration, when the Air in the right Lobe became rarer than the external Air, the left Lobe was compreſſed, and Part of the Air within it was, by the Preſſure of the external Air, forced back again into the Right, till the Equilibrium was again reſtored.

THUS it is evident, that whilſt the right Side of the Thorax is entire, the right Lobe will, when the Breaſt contracts, blow up the Left, and when it dilates, draw the Air out again and contract it.

THE Doctor ſeems to wonder at the Dog's immediately loſing his Voice after the Wound was made, more eſpecially as one ſide of the Thorax was left entire. Now, the Reaſon of this will very plainly appear, if it be conſidered, that tho' the Dog endeavours to cry, by making a forcible Expiration, and contracting the Orifice of the Wind-pipe, yet the Liberty the compreſſed Air has of eſcaping out of the right Lobe into the Left will prevent its paſſing out at the contracted Orifice of the Wind-pipe with ſuch a Velocity as is required to produce the acute Sound of Crying.

THE Pain, therefore, the Dog was in, and the fruitleſs Endeavours he made to expreſs that Pain by Crying, muſt, by preventing the Air from going freely out at the Wind-pipe, greatly contribute to the blowing up and contracting of the left Lobe, by the contrary Motions of the Right.

NOW, let us return to the latter Part of the Doctor's fifth Experiment.

"POSTQUAM ſic per ſemihoram vixiſſet, ſine ullâ vocis, " vel Reſpirationis læſione ſenſibili; Thorax ab uno latere aper- " tus fuit ulterius, *diſciſsâ coſsâ*. Tumque apparebat (magnum " pardoxum) pulmonem *contrahi*, dum pectus *dilatabatur*, *di-* " *latari* dum hoc *anguſtabatur*."

AFTER the Wound was thus enlarged on one Side, by taking away Part of the next Rib, the Dog was nearly in the ſame Condition with the Dog in our ſecond Experiment, when upon taking out one of the Canulæ, we had enlarged the Orifice ſo as to be able to thruſt our Fingers in and feel the Dilatation and Contraction of the Lobe on that Side the Mediaſtinum. Nevertheleſs, the Lobe which we felt in our Experiment, moſt undoubtedly contracted when the Thorax contracted, and dilated when that dilated; and in the Doctor's Experiment, the very Reverſe happened.

NOW, there were two Circumſtances in which we differed in making our Experiments; and from theſe alone proceeded the Difference in the Times of the dilating and contracting of the Lobes under our Conſideration.

IN the firſt Place, the Orifice in our Experiment was, on one Side, no larger than the Bore of the Canula of one of the Trocharts; and on the other, even when it was enlarged, it was not bigger than the ſmalleſt of the Doctor's.

AND in the next Place, the Mediaſtinum was pierced thro' in two ſeveral Places by the Trocharts, one of which was ſtill remaining in the Breaſt, ſo that the Air in one Cavity could not be more dilated, or condenſed, than the Air in the other.

But in the Doctor's Experiment the Mediaſtinum was entire, and the Wound, that was enlarged, was of a conſiderable Length, and as broad as two Interſtices between the Ribs, together with the Breadth of the Rib taken away; which muſt make a larger Orifice than that we made with the Trepan in our firſt Experiment, and conſequently muſt prevent all Motion in the Lobe on that Side, which would otherwiſe have followed upon the contracting and dilating of that Side of the Thorax.

Now, before this Orifice was thus enlarged, the Dog had lived near half an Hour with both Orifices open, without any ſenſible Alteration, either in his Voice, or in his Breathing: whence it is reaſonable to conclude, that the Side of the Thorax, where the Wound was not enlarged, was ſtill able to carry on the Office of Reſpiration with a tolerable Degree of Force.

Consequently, for the ſame Reaſons that in the Doctor's ſixth Experiment, the Lobe in that Side of the Thorax, which was entire, did alternately blow up, and exhauſt the Lobe on the other Side; it will follow, that the Lobe, on the Side where the ſmall Orifice was, muſt, in this Experiment, alternately blow up, and exhauſt the Lobe on the Side where the great Orifice was made, in the ſame manner, tho' not with the ſame force, as in the other Experiment; and therefore the Lobe, on the Side where the great Orifice was, muſt contract when the Breaſt dilated, and dilate when that contracted.

But in our Experiment, no ſuch contrary Motions could be produced in the Lobes, on the different Sides of the Mediaſtinum, both becauſe neither of our Wounds were large enough totally to deſtroy the Action of either Side of the Thorax upon the Air within, and becauſe of the free Communication which was opened by the Trocharts between the Air on both Sides the Mediaſtinum; and, therefore, the Air in both Cavities muſt be condenſed, and conſequently both Lobes be contracted, when the Breaſt contracted; and the Air in both Cavities muſt be dilated, and conſequently both Lobes be expanded, when the Breaſt expanded; which is agreeable to what we obſerved.

THUS have I gone thro' all the material Differences in the Doctor's Experiments, and ours; and ſhewn that they are agreeable to, and the Conſequences of, the Account of Reſpiration, delivered above.

BUT tho' I was fully ſatisfied myſelf with this Way of explaining the different Appearances in theſe Experiments, I could not help employing a Workman to make a Machine I had contrived, by which any one may be experimentally convinced of the Truth of what is here deliver'd, without undergoing the uneaſy Task of making Perforations into the Breaſts of living Animals: And as this Machine does perfectly anſwer the End I propoſed, I have ſubjoined a Print of it to theſe Papers; and ſhall now give a ſhort Deſcription of its Make, and the Manner of trying the Experiments with it.

ABCDEF repreſents two Cubical Frames, made of Wood, joined together, and ſcrewed into the Wooden Stand XYZ.

AT the two Ends ABF, CED, and in the Partition between the two Cubes, three ſquare braſs Plates are cemented into the Frames.

IN each of theſe Plates is made a large Hole; and over that Hole, a circular Plate is faſtened at its Center into the ſquare Plate, ſo as to be moveable upon that Center; and in this circular Plate there is another Hole, which correſponds to that in the ſquare Plate underneath it.

THIS is repreſented in the Figure at one end CDE, by the Letter P, and in the Partition by the Letter O; but that at the other End ABF is not to be ſeen, in the Poſition in which the Draught is taken; ſo that by moving the Plate P or O round upon its Center, you may either bring the two Holes together, or place them at a diſtance from one another, and by that means either open a Communication between the Air in both the Cubical

bical Boxes and the external Air, or prevent it; or by bringing the Hole in the circular Plate more or leſs over that in the ſquare Plate, make the Communication greater or leſs. At the two Ends, the Plate P is eaſily moved by the little Nob p; but that in the Partition O is turned by a Key, which is occaſionally put in thro' the Hole in the Plate P.

THE Four ſquare Frames, which compoſe the two Sides A B C, D E F, have Pieces of Glaſs carefully cemented into them.

THE Top is an oblong Piece of Braſs, cemented likewiſe into the Frame A F E, with two Holes in it, into which the hollow Tubes G and H are ſcrewed. Theſe Tubes G and H, are long enough to reach thro' into the two Cubical Boxes, one on each Side the Partition O; and to the Ends of theſe Tubes are faſtened two ſmall Bladders M and N, ſuited to the Size of the Boxes.

A COMMUNICATION is made from the hollow Tubes G and H, which are cloſed at Top, to the hollow Tube I, which is open at Top, by the ſhort Pipes G I and H I: So that when Air is blown into the Tube I, it paſſes thro' the Pipes I G, I H, into the Tubes G and H, and thence into the Bladders M and N, and blows them up; and if thoſe Bladders were to be ſqueezed flat again, the Air would be forced out through the Tube I.

THIS Tube I, therefore, repreſents the Wind-pipe; the Pipes I G, I H, and the Tubes G, H, repreſent the Bronchia, which go to each Side of the Thorax; the Bladders M, N, the Right and Left Lobes of the Lungs; the two Cubical Boxes, the Right and Left Cavities of the Thorax; and the Partition O, the Mediaſtinum. The little hollow Conical Piece of Braſs, K, with a very ſmall Orifice at Top, is contrived to ſkrew on upon the Tube I, occaſionally, to ſhew what Effect diminiſhing the Orifice of the Wind-pipe will have in Reſpiration.

THE Bottom of this Frame B C D, is made of Wood, and has two large circular Holes bored thro' it; and into each of theſe Holes is ſcrewed a large Wooden Rim, to which is faſtened tight one End of a large Bladder Q R, or S T; which Bladder is in the ſame manner cut at the other End, and tied round a large Cylindrical Piece of Wood R or S, which has no Hole in it. Thus is there a free Communication between the Air contained in theſe Bladders Q R, S T, and the Air in the Cavities of the Boxes immediately over them, which every way ſurrounds the Bladders M, N.

WHEN the Bladders Q R, S T, are wet, you may, by ſqueezing them hard, as is repreſented at S T, force the Air out of them into the Cavities of the Boxes; and by pulling the Bottoms forcibly down, by which you reduce the Bladders to their Cylindrical Forms again, as is repreſented at R, you may draw the Air out of the Cavities of the Boxes into thoſe Bladders again. Theſe Actions, therefore, if they are performed alternately, muſt alternately dilate, and compreſs, the Air in the Boxes, which immediately ſurrounds the other Bladders M, and N; and conſequently produce the ſame Effects upon thoſe Bladders, which the alternate enlarging and contracting of the Thorax does upon the Lobes of the Lungs on each Side of the Mediaſtinum.

IN order, therefore, to repreſent the Motion of the Lungs in natural and undiſturbed Reſpiration, we cloſe up the Hole in the Partition O, and blow in Air at the Tube I, till the Bladders M, and N, are blown up; leaving the other two Holes at the Ends open, that the Air in the Bladders, and in the Boxes, may be of an equal Denſity; and then we cloſe the Holes at the Ends likewiſe.

WHEN this is done, if we alternately contract and enlarge the two Bladders R Q, S T; the Bladders M, N, will be alternately contracted, and dilated, as the Lungs are in Reſpiration: and the Air will be alternately forced out, and taken in, at the Orifice of the Tube I, as it is at the Orifice of the Wind-pipe in living Animals.

WHEN both the Bladders, without the Boxes, are ſqueezed, as S T is repreſented in the Figure, the other Bladders will appear as N does; and when they are drawn out, as Q R is repreſented, thoſe within the Boxes will appear as M does.

THIS being underſtood, it is eaſy to ſee how the Experiment may be varied by Means of the moveable Plates at the Ends of the Frame, and in the Partition, ſo as to repreſent the Motion of the Lungs, when Reſpiration is diſturbed by Perforations made either into one or both Sides of the Thorax, or thro' the Mediaſtinum.

IT is ſufficient to add, that I have made the Experiment in all the different Circumſtances of Dr. *Houſton*'s Experiments and mine, and found the Events in this Machine to anſwer exactly with the Deſcriptions given above.

I CONTRIVED a Way, of making an Experiment to anſwer the Fifth of Dr. *Houſton*'s, in which the Ends of the Lobes were thrown out at the Orifice of the Wounds, and continued ſo for ſome Time.

I TOOK a ſmall Cylindrical Piece of Cork, and thruſt a Crow-Quill, open at both Ends, thro' it. This I dropt into the Bladder N, before it was faſtened to the End of the Tube H; and when I had got the End of that Bladder out of the Hole, I held it faſt there, by means of the Braſs Plate P; ſo that notwithſtanding it ſqueezed the Bladder tight upon the Cork within it, and ſo ſtop'd the Orifice cloſe, there was a free Paſſage for the Air thro' the Crow-Quill to paſs from that Part of the Bladder within the Box, to that which hung out at the Hole.

THE Event was the ſame. The Part, which hung out, dilated, when that within contracted; and contracted, when that dilated.

I FOUND, likewiſe, when the Hole at P was made very large, and the Bladders M and N did in conſequence of it dilate, and contract, at different Times; that they did it much more remarkably when the Orifice of the Tube I was diminiſhed by ſcrewing on the Piece K: Which is an experimental Proof, that the Dog's endeavouring to cry, in the Doctor's Sixth Experiment, contributed greatly to the Motion of the Lobe on that Side of the Thorax, where the large Wound was made; which in all Probability would not otherwiſe have been ſo diſcernible in the languid State the Dog muſt have been in, after ſo long an Experiment.

AND that all theſe different Effects depend entirely upon the different Sizes of the Apertures, may be ſeen experimentally, by this Machine, if at firſt we gradually open one only of the Apertures, *viz.* that at the End P, and afterwards the other, till they become of their greateſt Extent; and all the while, continue alternately ſqueezing, and dilating, the Bladders Q R, S T.

FOR, 1. Whilſt the Aperture at P is very ſmall, in Proportion to the Space between the Bladder N, and the Sides of the Box which contains it; the two Bladders will dilate and contract together, and little or no Alteration will be made in the Motion of the Bladder N.

2. As the Size of the Aperture encreaſes, the Bladder N will have leſs and leſs Motion; but ſtill the Dilatations and Contractions of this Bladder will happen at the ſame Time with thoſe of the other.

3. IF the Aperture be ſtill encreaſed, the Motion of the Bladder N will grow ſtronger again; and the more ſo, the more

the Aperture is encreaſed; but then it will dilate when the other contracts, and contract when that dilates.

4. BETWEEN the Times of the Motion of the Bladder N's diminiſhing, and afterwards encreaſing again in a contrary Direction, there muſt be a Time, when it will have no Motion at all communicated to it, notwithſtanding that the Bladder on the oppoſite Side dilates, and contracts, regularly; and conſequently, there is one certain Size, to which if the Aperture P be opened, the Bladder N will be quite at Reſt.

5. IF now the Aperture be gradually opened at the other End, there will be little or no Alteration in theſe Appearances, whilſt it is very ſmall; but as it gradually encreaſes, the Motion of both the Bladders will gradually decay, till they come to nothing.

AND, laſtly, if at any Time during this Experiment, the Aperture at P, (or both of them, after they have both been opened) be ſtop'd up on a ſudden; both the Bladders will immediately dilate and contract at the ſame Time, as they did at firſt; and in a greater, or leſs Degree, according as there was a leſs, or a greater Quantity of Air in the Cavities of the Boxes, when the Apertures were ſtop'd up.

IF we try the Experiment another Way, by gradually opening both the Apertures together, we ſhall find little or no Alteration at firſt, whilſt they are very ſmall; but as they encreaſe, the Motion of both Bladders will gradually decay, till they come to nothing; but they will all the while dilate and contract together.

MAY we not, from all theſe Experiments taken together, fairly conclude that Perforations may be made into both the Cavities of the Breaſt, nay, and thro' the Mediaſtinum too, without immediately killing the Perſon, provided thoſe Perforations are very ſmall; and conſequently, that a Perſon may be run through the Breaſt with a ſmall Sword, without the Wound's being mortal, provided the Lungs themſelves be not greatly wounded?

AND with Regard to Practice, may we not be certain that, in Caſes of abſolute Neceſſity, we may ſafely make a Perforation into the Cavity of the Breaſt, not only on one, but on both Sides, to let out either Water or a Collection of Matter, provided we make not the Orifice too large? And conſequently, that the ſmalleſt Orifice, ſufficient to let out the Fluid, is the beſt?

THAT if any Difficulty, Interruption, or Convulſion, in breathing, ſhould happen upon the firſt making the Aperture, ſtopping the Orifice with the Finger, from Time to Time, whilſt the Fluid is diſcharging, will moſt remarkably aſſiſt the Patient, and eaſe that Complaint? This I not only know from Theory, but from Fact alſo in two remarkable Inſtances.

AND as it is moſt commonly neceſſary, in Caſes of this Kind, to keep the Orifice open, in order to procure a conſtant Diſcharge for ſome Time, that it is better to do it by leaving a Piece of Rag, or a Skain of Silk in the Wound, than by thruſting in a Canula; becauſe in one Caſe, you leave an Orifice of a conſiderable Size open, and in the other you leave none, the Parts about it naturally ſticking to the Rag?

WHAT I have here ſaid with Regard to the Safety of making an Aperture into the Cavity of the Breaſt, relates only to the Motion of the Lungs in Reſpiration; which it has been generally ſuppoſed would be affected in the moſt dangerous Manner by it. And I think it evident from what has been ſaid, that it may ſafely be attempted by any one, who takes proper Precautions, and knows where to make the Aperture properly, ſo as not to cut either an Artery, or Nerve, and to afford the readieſt Diſcharge for the Fluid he wants to let out.

It is to be ſuppoſed that no one will ever attempt ſuch an Operation, but when he thinks a Life may be ſaved by it; and it muſt be right to have every one, who may poſſibly be called to perform it, apprized of the propereſt Way to do it, and of all the Conſequences of it. Nor will it be a ſmall Satisfaction to any one in ſuch Circumſtances, to know, by a Number of Experiments, that, if he be deceived in his Judgment, and there be no Fluid in the Cavity to let out, the Operation, properly performed, will not endanger the Perſon's Life; and that Reſpiration will go on, as well as if it had never been performed; and if ſo, that the Orifice will heal almoſt as ſoon as a common Iſſue.

Thus much I thought, it was proper to ſay on this Subject, not with a View to encourage any one to perform this Operation, without the ſtrongeſt Proofs of its being the only Way to preſerve the Patient; but in order to remove the Dread of doing it, when it is neceſſary, and to ſhew the propereſt Way of doing it with Safety: And what has more determined me to ſay ſo much of it, is, that I know it to be fact, that there is a young Gentleman alive, who underwent the Operation, and has enjoyed many Years of perfect Health, even ſince the Orifice was healed up.

I shall only add a few Remarks upon the firſt Part of the Doctor's Sixth Experiment; from which he ſeems a little too haſtily to conclude, that the Lungs fill up the whole Cavity of the Thorax, (except what is taken up by the Heart, Pericardium, *&c.)* and have their Surfaces cloſely applied to the Pleura, whilſt the Thorax is entire.

" Membrana, Pleura dicta, hoc modo nudata, hæcce aſpi-
" cientibus exhibuit phænomena.

" Dum pectus dilatabatur, apparebat intus membranæ appli-
" catum aliquod album; dum vero anguſtabatur pectus, et ex-

pirab

" ſpirabat Animal, album illud ſurſum fugiens locum ceſſit aſ-
" cendenti cuidam corpori rubro; tumque mox dilatante ſe pe-
" ctore, rubrum iterum deſcendit, locum ejus occupante albo, &
" ſic per vices."

" HOC viſo, ſuperius coſtarum interſtitium etiam muſculis
" nudavimus, ſed eo in loco apparuit nil niſi album."

" MEMBRANA, utrâque parte, quâ nudata erat, dum pe-
" ctus dilatabatur, fiebat concava; dum anguſtabatur, paulu-
" lum, ſed vix ſenſibiliter convexa."

" IN ſexto Experimento," ſays the Doctor, " Res ipſa loquitur
" album corpus Pulmonem fuiſſe, rubrum Diaphragma: Quin
" et Pulmones Thoracem integrum replere, ejuſque Membranæ
" ſuperficie ſuâ applicari, ut vulgo creditur."

IT ſeems, indeed, very evident, that the red Appearance of the Pleura, which is naturally white, was owing to the Diaphragm; becauſe when the Pleura was laid bare, higher up, out of the Reach of the Diaphragm, there was no ſuch alternate Appearance of red and white, *in eo loco apparuit nil niſi album.* But it is by no means ſo certain, that the white Body, as the Doctor calls it, was the Surface of the Lungs.

FOR, is it not reaſonable to imagine, that there is a viſible Difference between the Colour of the Lungs in Inſpiration, when the Blood has a free Paſſage allowed it thro' all their minuteſt Veſſels; and in Expiration, when thoſe Veſſels are ſqueezed together?

AND if ſo, would not this Difference be diſcernible thro' the tranſparent Pleura?

HOW then could the uppermoſt of the two Parts of the Pleura, which were laid bare, have the ſame white Appearance, both when the Breaſt dilated, and when it contracted?

MAY we not, therefore, juſt as reaſonably aſſert, that the White was the natural Colour of the Pleura itſelf, and that the

Surface of the Lungs was not at all applied to it, either in Inſpiration or Expiration?

THE Thing, therefore, does not ſpeak itſelf ſo plainly, but that it will admit of Diſpute, even if no farther Account had been given us of this Experiment: But there are ſome other Circumſtances, which remain to be conſidered, and ſeem to me ſufficient to determine the Point in diſpute.

"MEMBRANA, utrâque parte, quâ nudata erat, dum pectus *dilatabatur*, fiebat *concava*; dum anguſtabatur, *paululum*, ſed vix ſenſibiliter, *convexa*."

LET us ſee how theſe Appearances will agree with both our Hypotheſes.

THE Pleura, as it lines the Cavity of the Thorax, is extended from the internal Surface of one Rib to the internal Surface of the other; ſo that, when it is laid bare by removing the intercoſtal Muſcles, there is a ſort of deep Furrow between the two Ribs.

IN Inſpiration, the Ribs, more eſpecially the middle ones, are at their greateſt Diſtance from one another, and conſequently, if no other Cauſe intervened, the Pleura which lies between them would be ſtretched ſo as to appear plane; and if the Lobe of the Lungs, which is upon the ſtretch likewiſe in Inſpiration, had its Surface applied to it, it would rather make it convex, than ſuffer it to be concave.

AND in Expiration, upon a Suppoſition that there is no Air in the Cavity, the external Air muſt keep the Pleura cloſe to the Surface of the Lungs; and conſequently, as the Lungs ſubſide, it muſt rather ſqueeze the Pleura inwards, and render it concave, than ſuffer it to be convex.

BUT on the Suppoſition, that there is Air in the Cavity of the Breaſt, and that the Surface of the Lungs is not every where applied to the Pleura; it will follow, that in Inſpiration, at which

Time the Cavity is enlarged, and the Air within it is rendered more rare than the Air in the Lungs, or than the external Air, the Pleura will be more preſſed on the Outſide by the external Air, than on the Inſide by the Air in the Cavity; and conſequently muſt be preſſed in, and appear *concave*.

AND in Expiration, when the Cavity is leſſened, and the Superiority of Force is given to the Air within it, the Pleura muſt be preſſed out, and appear *convex*.

I KNOW no Reaſon why the Concavity of it in Inſpiration ſhould be more ſenſible, than the Convexity in Expiration, unleſs it ariſes from the Situation of the Pleura at the Bottom of the Furrow between the Ribs. It may be, that when the Pleura is concave, the Whole of it, that lies between the two Ribs, is viſible to the Eye; whereas when it is convex, its Edges are applied to the rounding Edges of the Ribs; and what is ſeen appears more upon a level, than it really is.

UPON all the Circumſtances of this Experiment thus compared together, it ſeems more reaſonable to conclude that there is Air in the Cavity of the Thorax; and that the Surface of the Lungs is not always, nor in every Part of it, applied to the Pleura; than the contrary.

I WOULD not, however, be underſtood, in Oppoſition to almoſt every one who has writ on this Subject, to aſſert, that the Surface of the Lungs, in a healthy State, is no where applied to the Pleura. On the contrary, it ſeems reaſonable to believe, that at the Top, where the Shape of the Lobes ſo exactly correſponds to the Shape of the Thorax, their Surfaces are almoſt conſtantly applied together: But towards the Ends, where the Lobes grow taper, (and hereabouts the Doctor laid the Pleura bare,) I believe they are very rarely, if ever, in immediate Contact, in eaſy and natural Reſpiration.

THUS much I thought was proper to add upon ſeeing theſe Papers of Dr. *Houſton*'s; and I leave our different Ways of

Reaſoning upon the ſame Experiments, to the Judgment of the Reader. But I cannot conclude without taking Notice of the great Accuracy he has ſhewn in obſerving, as well as Faithfulneſs in relating, every the minuteſt Appearance that offered itſelf whilſt he was making his Experiments; for to theſe it is owing, if any Improvements have been made in the Reaſoning upon them.

N. B. Having had an Opportunity of ſeeing a very exact Diſſection of the Muſcles, ſubſervient to Reſpiration, which properly belong to the Ribs; I thought it would be no diſagreeable Preſent to my Readers, to annex to theſe Sheets as accurate Draughts of them, as I could procure.

THEY ſeem to me to be ſo exactly copied after Nature, and the Muſcular Fibres are expreſſed in ſo maſterly a Manner, that they require no particular Explanation. It were Pity indeed to ſpoil their Beauty by a Number of References.

ERRATA.

Page 10. line 13. and in other Places, *for* Hœmaſtaticks, *read* Hæmaſtaticks. P. 16. l. 6. from the Bottom, and in other Places, for *forceable* read *forcible*. P. 18. l. 12. from the Bottom, for *every* read *each*. P. 31. l. penult. after *Viſcus*, for a , make a . ; and blot out the laſt Line entirely. P. 47. l. 10. for *of component Particles* read *of the component Particles*. P. 48. l. 4. from the Bottom, for *Vapour* read *Vapours*. P. 51. l. 8. from the Bottom, for *all that can be*, read *what is there*. P. 58. l. 16. for *Breathe* read *Breath*. P. 99. l. 6. from the Bottom, for *Alvini* read *Alvi*. Append. P. 6. l. 14. for *into* read *to*. P. 12. l. 18. dele *with*.

MVSEVM BRITANNICVM

Plate I.

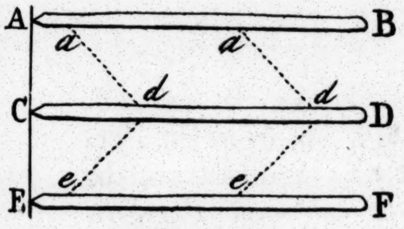


Fig. I.

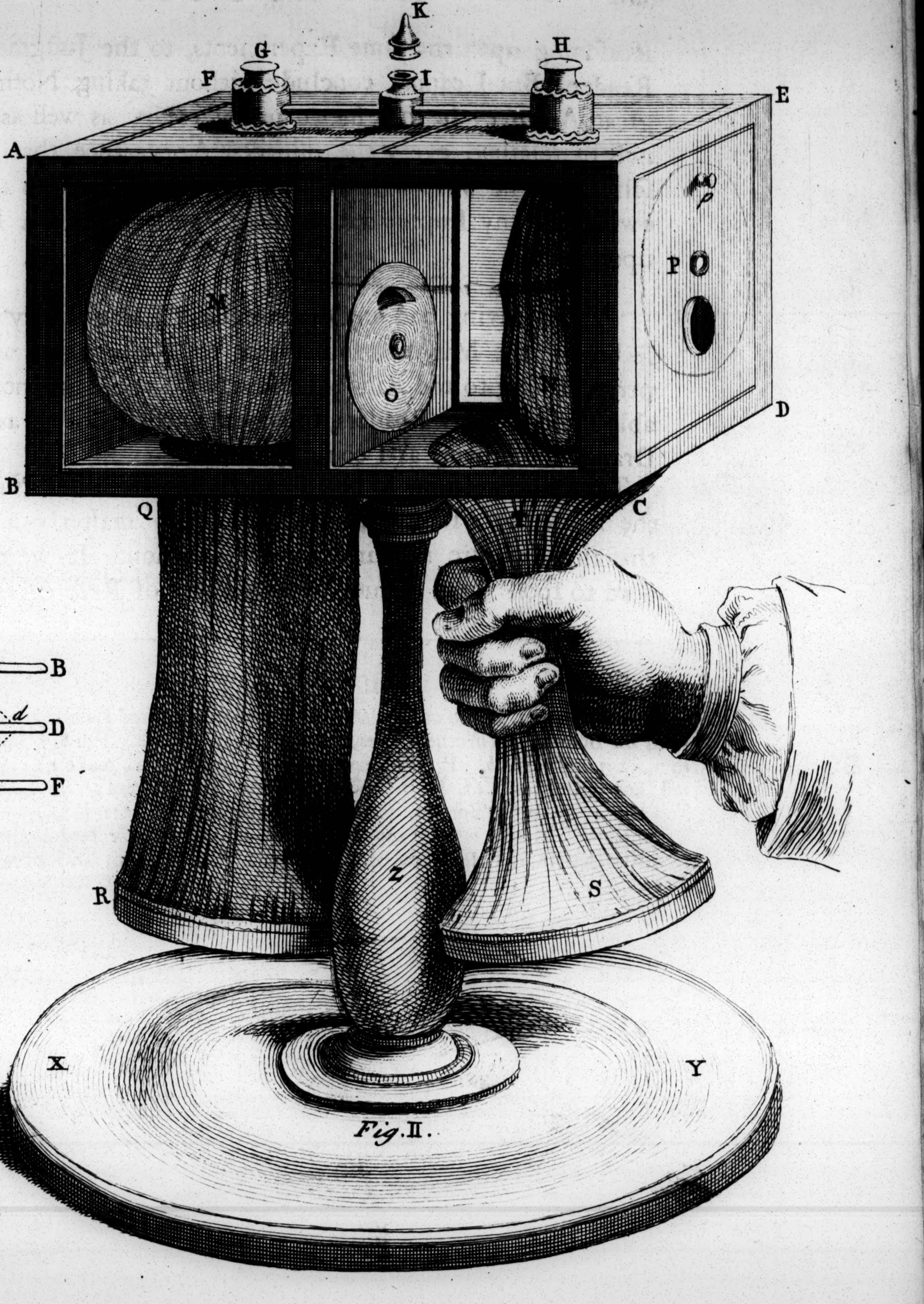
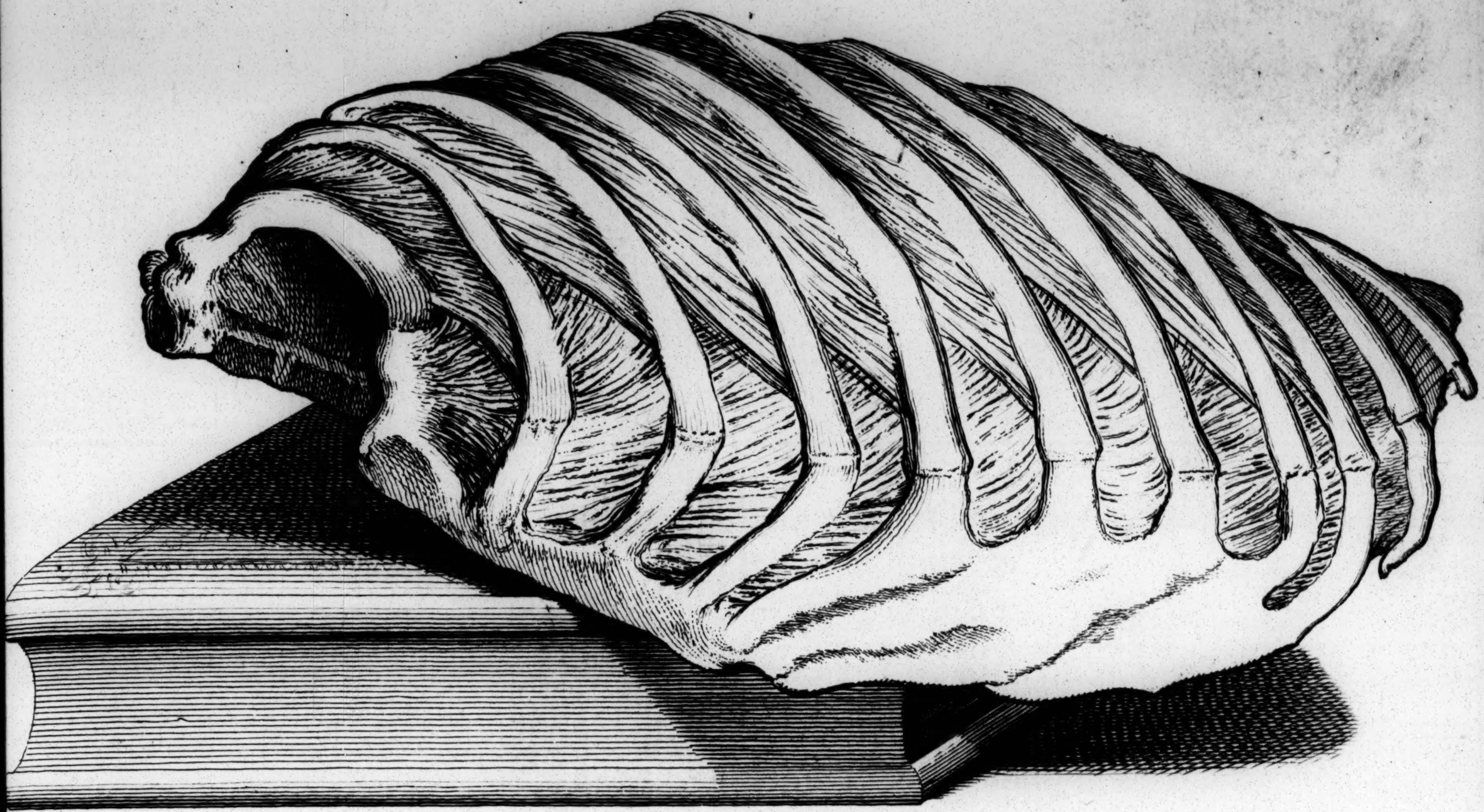
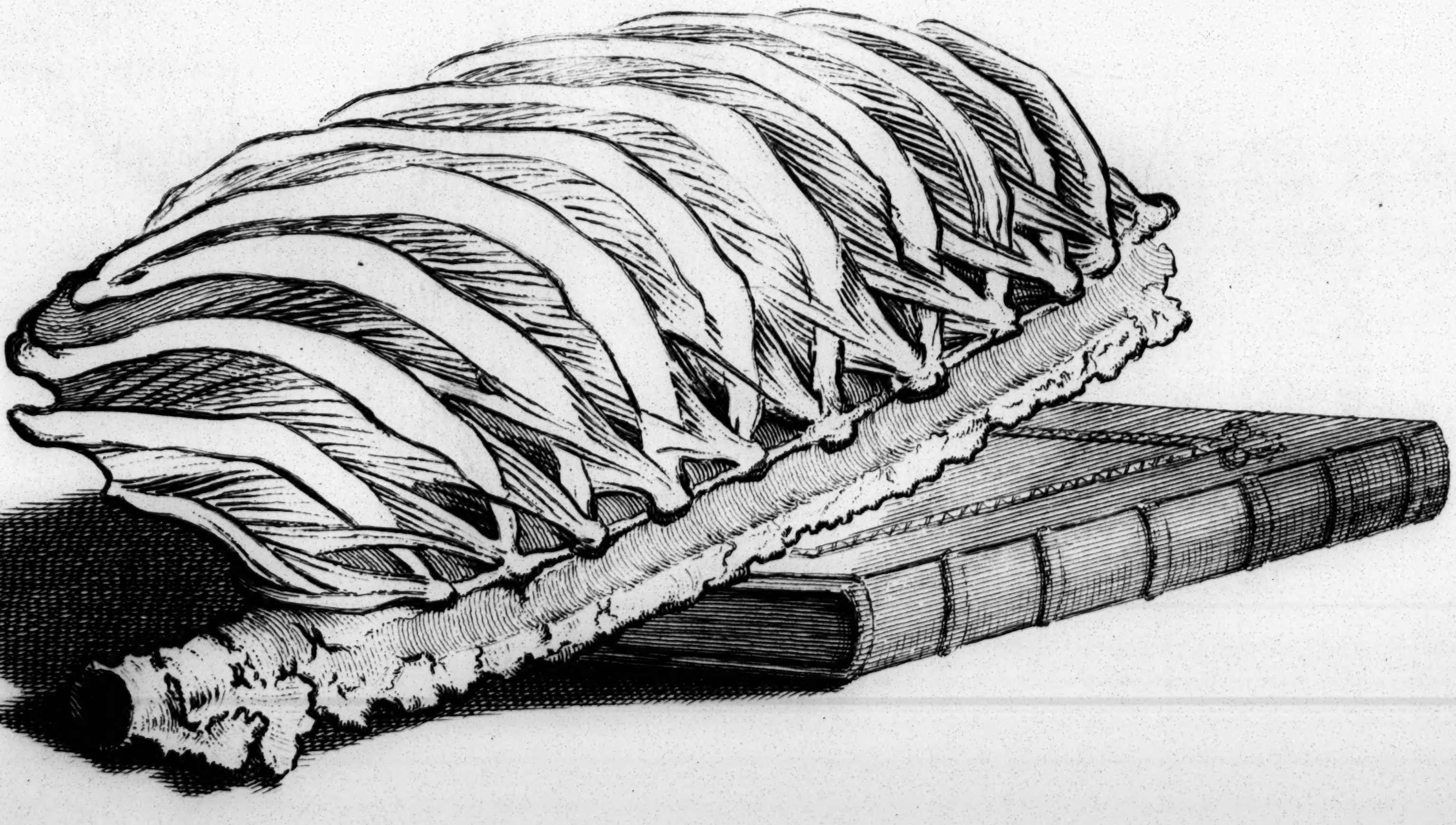


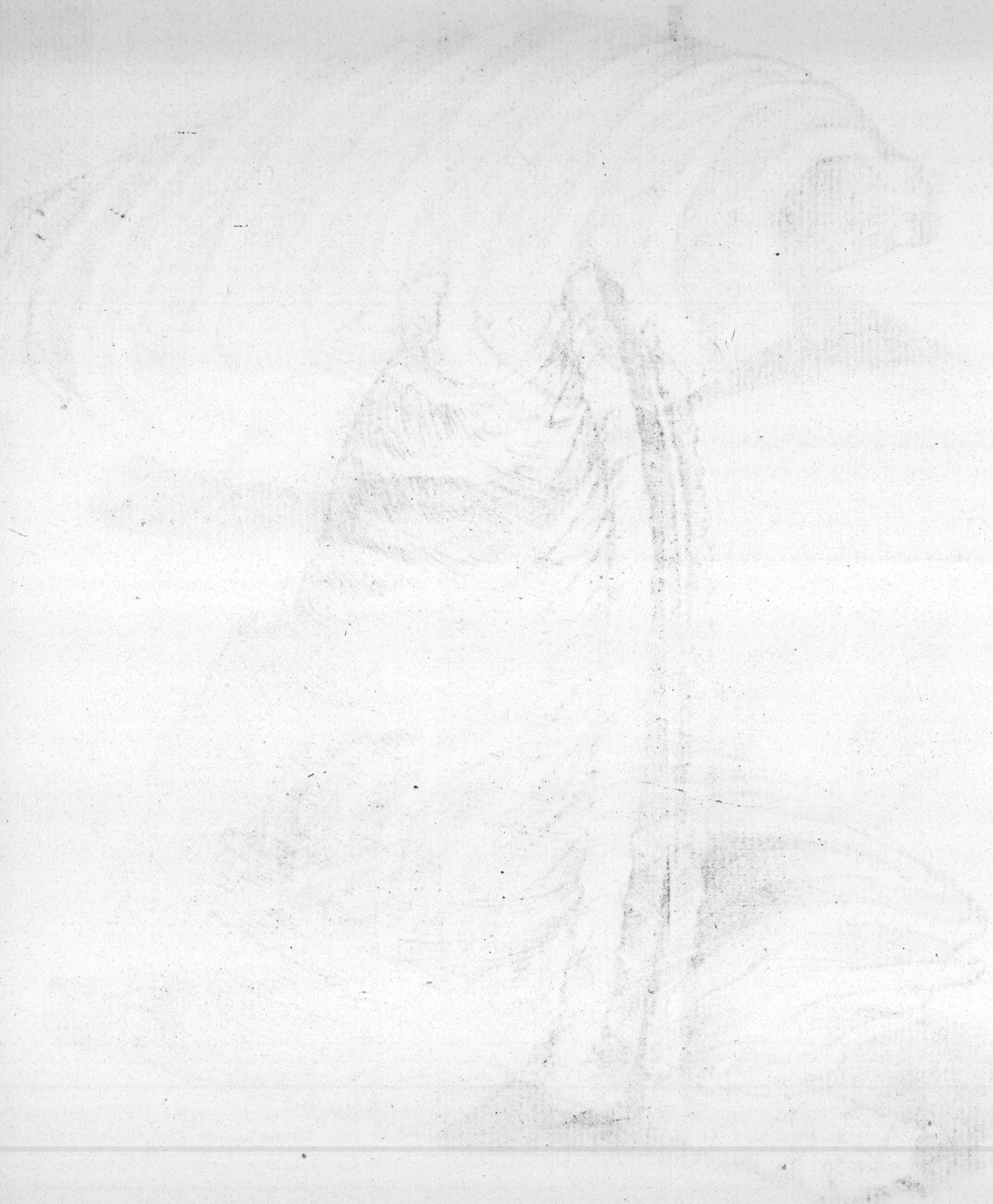
Fig. II.

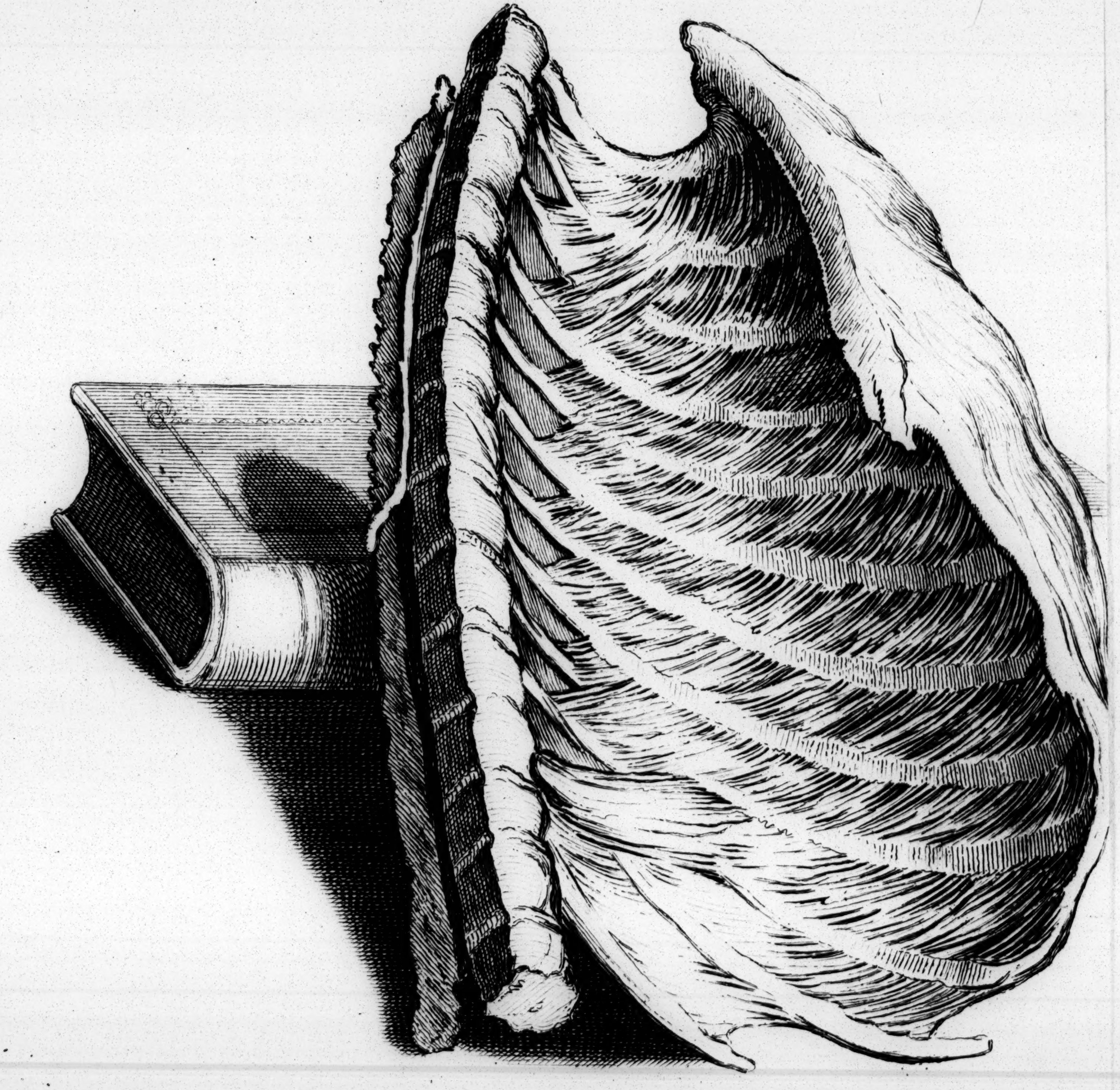
R. Parr Sculp

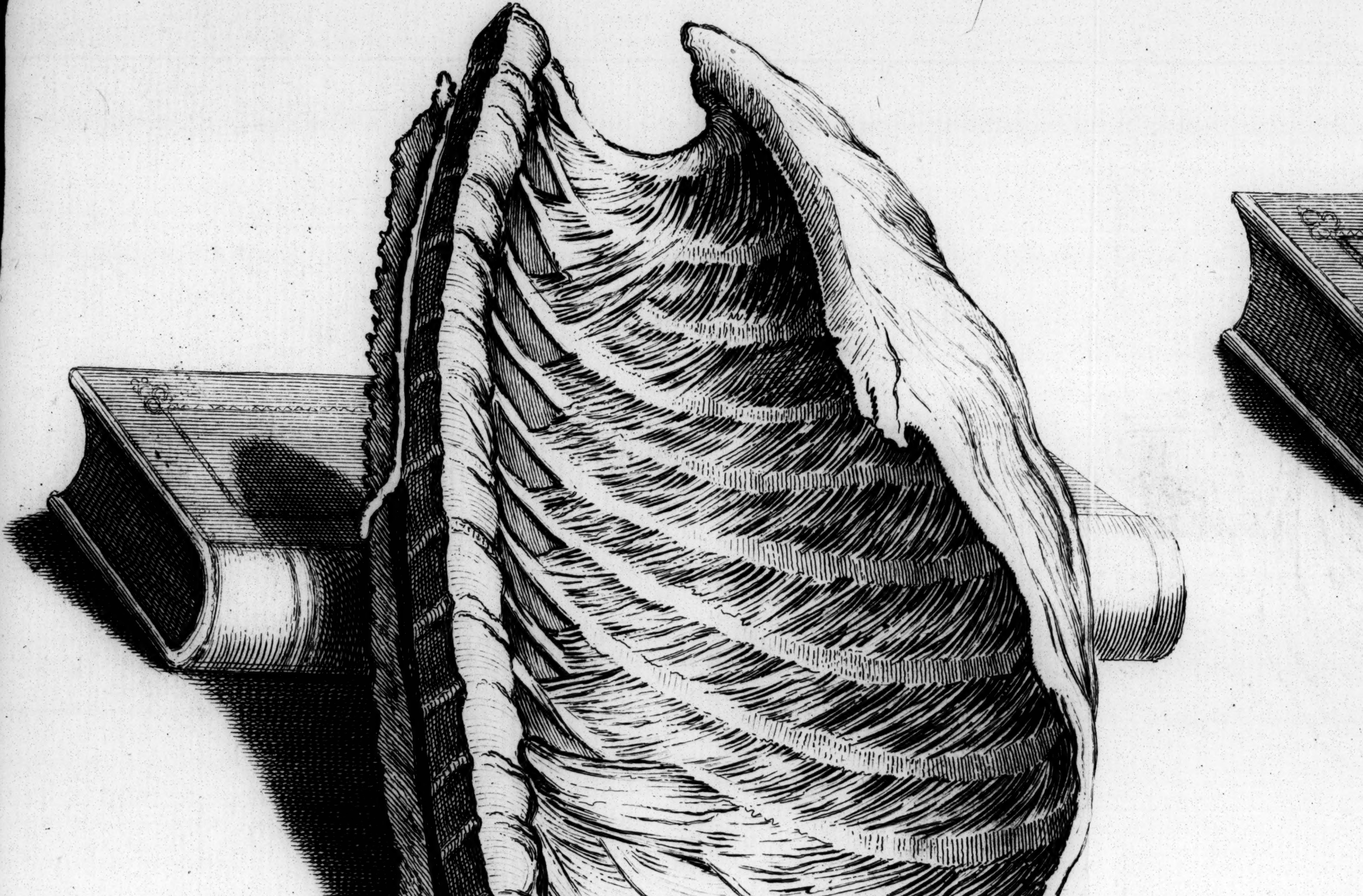


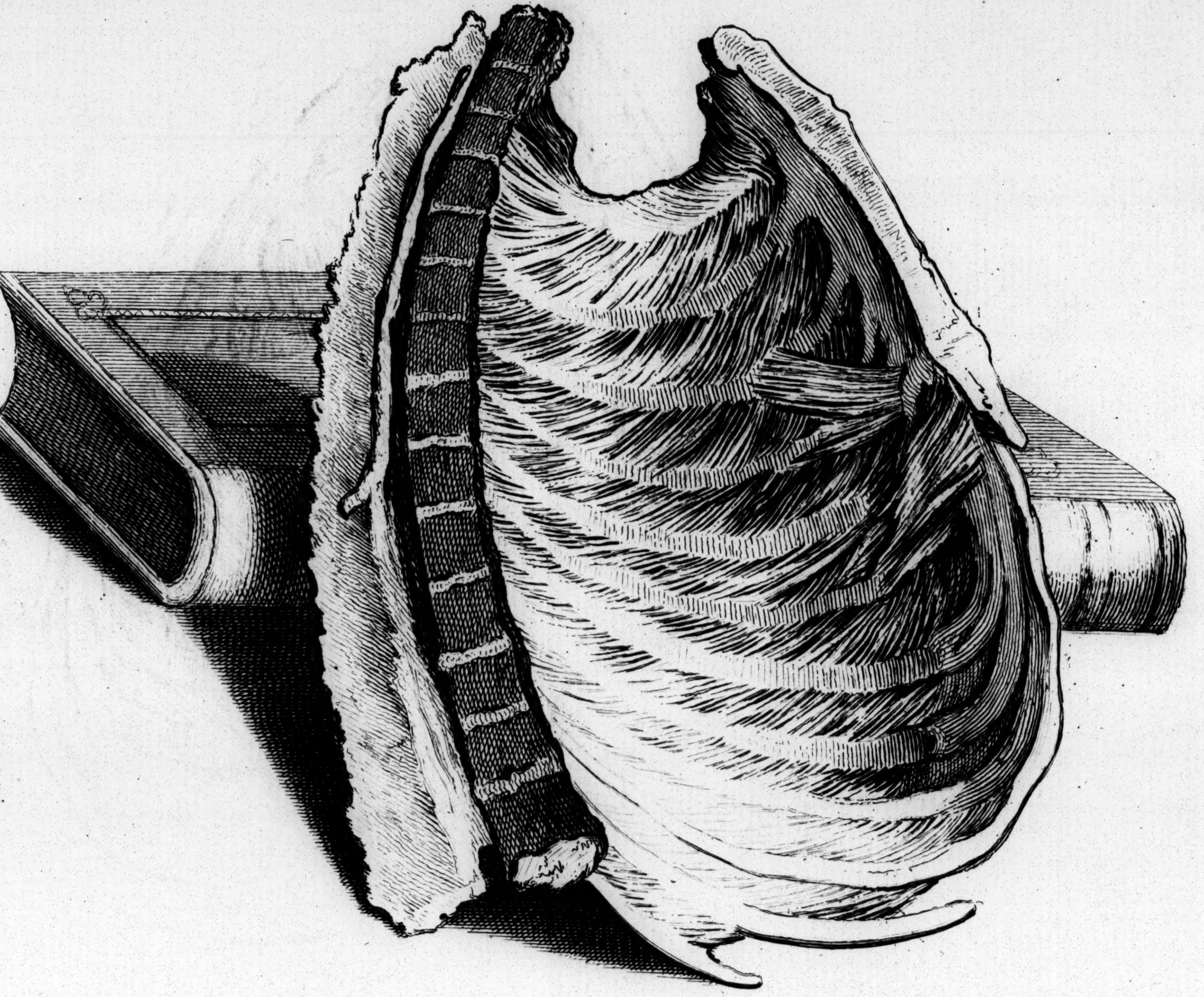


R. Parr Sculp









R. Parr Sculp